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ABSTRACT

This instructor's guide contains the materials required to teach a competency-based introductory course in sheet metal work to students who have chosen to explore careers in construction. The following topics are covered in the course's three instructional units: sheet metal materials, sheet metal tools, and applied skills. Each unit contains some or all of the following: objective sheets, suggested activities, supplemental information/activities to be presented at the instructor's discretion, information sheets, sheets of supplementary information to assist students in solving problems, transparency masters, instructional supplements containing suggestions for teaching basic skills, assignment sheets, job sheets, practical tests, written tests, and answers to assignment sheets and tests. Academic skills training is combined with vocational training throughout the instructional materials, and a system of icons has been used to help instructors identify activities into which training in the following basic skill areas has been infused: reading, science, creative thinking/problem solving, writing, oral communication, employability, math, interpersonal skills, and social studies. Most units of instruction are designed for use in more than one lesson or class period of instruction. These materials precede the instructional units: information on basic skills in curriculum, information on measuring student performance gains, and required criteria for a competency-based education program. A competency profile and basic skills matrix are included. (MN)

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introduction to construction series

introduction to sheet metal

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA

votech

instructor edition

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Introduction To Sheet Metal

Developed as a Cooperative Project by
the Associated General Contractors of America
William W. Brown, Chairman, Manpower and Training Committee
and
Curriculum and Instructional Materials Center,
Oklahoma Department of Vocational and Technical Education

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Curriculum and Instructional Materials Center

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Introduction To Sheet Metal

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FOREWORD

In 1985, The Associated General Contractors of America (AGC) met with representatives of the Oklahoma Curriculum and Instructional Materials Center (CIMC) to discuss the possibilities of developing, as a cooperative project a course of instruction designed for training individuals who choose to seriously explore careers in construction.

This revised publication is the result of those original discussions and updates made through close coordination among general contractors and vocational educators. This series represents conscious effort to coordinate the practical experience of personnel in the carpentry industry with the best instructional methods of those in the field of vocational education.

Although this book reflects a systematic approach to instructional materials development and the latest in educational technology innovations, the information in the Introduction To Sheet Metal manual should be adapted and modified to coincide with local conditions.

Roy Peters, Jr.
State Director
Oklahoma Department of Vocational
and Technical Education

William. W. Brown, Chairman
Manpower and Training Committee
The Associated General Contractors
of America

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PREFACE

Construction requires that students have many skills and related information to become productive workers in this challenging field. Workers must be better trained and equipped to find and retain meaningful employment.

Instructional materials in this manual is written in terms of student performance, using measurable behavioral learning process. Criterion-referenced evaluation instrument provide for a uniform measurement of student progress.

The purpose of this manual is to assist instructors in all construction related areas in providing instruction throughout the industry. Any information in this manual that does not concur with the instructor's course of study should be modified to meet personal needs.

Personnel safety is of prime concern, as an instructor you are encouraged to closely observe and couch students in all safety issues. We have done much to advise students of possible dangers, but your close supervision and alertness can't be overemphasized.

Al Willey
Curriculum and Instructional
Materials Center
Oklahoma Department of Vocational
and Technical Education

ACKNOWLEDGEMENTS

Much appreciation is expressed to the many individuals who contributed their time, talents, and knowledge in the revision of this manual.

Thank you to the following ad hoc committee members, AGC staff representatives, and the staff of the Oklahoma Department of Vocational and Technical Education.

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USE OF THIS PUBLICATION
INSTRUCTIONAL UNIT

Introduction to Sheet Metal contains three units. Each instructional unit includes some or all of the basic components of a unit of instruction: performance objectives, suggested activities for the instructor, extensions and options, information sheets, students supplements, transparency masters, instructional supplements, assignment sheets, job sheets, practical tests, written test, and answers to assignment sheets and written test, all of which are included in the instructor's edition. The student workbook includes the objective sheets, information sheets, student supplements, transparency masters, assignment sheets, and job sheets. Written tests may be duplicated for classroom use or *additional copies* may be purchased by calling 1-800-654-4502 or, in Oklahoma, 1-800-522-5810, ext. 589.

All of the unit components tie into measurable and observable learning outcomes. Instructors are encouraged to supplement these components with other resources in order to make them as responsive to local conditions and individual needs as possible.

Most units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the instructor will help him or her determine the following:

- Amount of material that can be covered in each class period.
- Skills that must be demonstrated.
  - Supplies and equipment needed
  - Amount of class time needed for demonstrations
  - Amount of time needed for student practice
- Supplementary materials, including print and non-print media, that must be ordered.
- Resource people who must be contacted.

Objective Sheet (White Pages)

Each unit of instruction is based on the performance needed for successful employment in an occupational area. Performance objectives are stated in two forms. The unit objectives states the overall goal of the unit. It tells what the student should be able to do and what standard will be used to see whether the student can do it. Specific objectives outline the teaching sequence of the competencies required to meet the unit objective.

The objectives should be provided for students and stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Instructors should prepare for each unit by deciding how each objective could be best taught.

Instructors should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the instructor should remember to supply the needed information, assignment and/or job sheets, and criterion-referenced test items.

Suggested Activities (Pink Pages) – **Instructor's Edition only**

The suggested activities page assists the instructor during the preparation stage of the teaching/learning process by providing suggestions for delivery, application, and evaluation during the instructional process. The instructor should read the suggested activities prior to introducing the unit to allow time to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the instructor will vary according to the particular unit.

References used in the development of each unit are listed in the "Suggested Resources" section, along with print and non-print media that may be used to teach the unit. These materials can be used by the instructor to supplement his or her knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

Extensions and Options (White Pages) – **Instructor's Edition only**

Extensions and Options are supplemental material that is not testable or graded and is nice-to-know. Extensions and Options provide the instructor with additional activities, fact sheets, art, controversial items, and extra practice sheets. They may also include items for the gifted or remedial student. Extensions and Options are used at the discretion of the instructor.

Information Sheets (Green Pages)

The information sheet provides "must know" content essential for meeting the cognitive objectives stated at the beginning of each unit. It serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective.

Students should read the information sheet before it is discussed in class. Space is provided in margins for students and instructors to add notes that clarify and/or expand on the information provided.

The information sheet may include notes, cautions, or warnings. These should be discussed carefully and thoroughly. **Notes** are short verbal additions to the information sheet or procedural outline that provide nice-to-know and decision-making information. A note may tell the student what to watch for or to consider at a given step. It may explain when a step may not be applicable. Notes offer guidance that may help the student understand the process and do it more efficiently. **Cautions** are advisories that tell the student how to avoid causing minor personal injury or equipment damage. **Warnings** are advisories to the student used to avoid serious personal injury or death to the student, persons in the workplace, or users of the project or the procedure.

Student Supplement (Green Pages)

Student supplements include instructions that could be used for solving problems or reinforcing the enrichment of learning. The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignment or job sheets. While supplements are not tested over directly, they may be used to assist in meeting the performance objectives.

Transparency Masters (White Pages) - **Instructor's Edition only**

Transparency masters provide information in a special way. The students may see as well as hear the materials being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information or assignment sheets.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion.

Instructional Supplements (Pink Pages) — **Instructor's Edition only**

Instructional Supplements provide suggestions for teaching the basic skills included in each assignment sheet or job sheet. They are located directly in front of the components they support—assignment or job sheets—in each unit.

Assignment Sheets (Tan Pages)

Assignment sheets provide students with information and exercises that address learning levels at or above the application level of Bloom's taxonomy. Assignment sheets provide written exercises for instruction and practice of a specific objective. The introduction to the assignment sheet explains how the assignment sheet relates to the subject area and unit component for such information.

Assignment Sheet Answers (Pink Pages) – **Instructor's Edition only**

This component is designed to assist the instructor in evaluating student performance on assignment sheets.

Job Sheet (Blue Pages)

Job Sheets are another important segment of a unit of instruction. The job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure to complete each task or job. Diagrams, photographs, and illustration are provided to assist students in achieving the skill.

The instructor should demonstrate the procedure outlined in each job sheet. Furthermore, the instructor needs to localize the procedure according to the equipment and supplies available in the local lab or salon situation. Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

Practical Tests (Yellow Pages) – **Instructor's Edition only**

The practical tests are designed to assist the instructor in the evaluation of the psychomotor activities (job sheets). The practical test provides instructors with a valid mechanism for determining a student's level of ability in performing the procedure stated on the job sheet. The check-off list allows instructors to evaluate a student's process performance of the task on the job sheet. The overall competency indicator allows the instructor to evaluate the end product.

Written Test (Yellow Pages) – **Instructor's Edition only**

This component provides criterion-referenced evaluation of every objective listed in the unit of instruction. If objectives have been added, deleted, or modified, appropriate changes should be made on the test.

In order to measure and document student competency gains as required by the latest Carl Perkins regulations, and as outlined in the Oklahoma-developed system of standards and measures, it is *absolutely essential* that the same test be used as a pretest and as a posttest. If you choose to use tests other than the ones included herein, be sure that the same instrument is used for each activity–pre- and post test.

A detailed explanation of the Oklahoma plan for standards and measures and the Carl Perkins requirements is included in the CIMC publication, *Measuring Learning & Competency Gain: The Pretest/Posttest Approach.* This booklet and accompanying software designed to assist in calculating and recording student gains are available to all vocational teachers through the school's vocational testing liaison.

To further assist vocational teachers, the CIMC is in the process of developing test code sheets for each written test in its more recent publications, including this one. These code sheets are explained in Section 8 of the publication mentioned above, and will greatly assist in verifying that the test is a valid instrument for measuring student learning and competency gains. As the test code sheets for programs become available, they will be forwarded to teachers of each program; further publications will include the test code sheets.

Written Test Answers (Pink Pages) – **Instructor's Edition only**

This component is designed to assist the instructor in evaluating student performance on written tests.

COMPETENCY PROFILES

A competency profile is in the front of each publication. Competency profiles document student performance. The profile contains a list of the specific job competencies that a student should achieve before leaving the training program.

PAGE NUMBERING

Each publication for the Curriculum and Instructional Materials Center is usually assigned a specific abbreviation. ***Introduction to Sheet Metal*** has not been abbreviated. Each unit will be recognized by the unit number in Arabic numerals. Each unit in the publication begins with page 1. Each page number gives the component name, book title, unit number, and page number within the unit. Since some CIMC publications are loose-leaf, this system of page numbering was recently adopted so that pages from different manuals would not get mixed up. The page number for the objective sheet in Introduction to Sheet Metal, which is unit 2, would look like this:

OBJECTIVE SHEET - **Introduction to Sheet Metal**
CIMC - A2 - 1

METHODS OF DISSEMINATING MATERIAL

For best results, provide student materials for each student. Student workbooks contain objective sheets, information sheets, supplements, transparency masters, assignment sheets, and job sheets. Pretest, practical tests, and written tests are packaged separately for students, and can be stored until needed. Students should be allowed to take their materials home at the end of the course.

TEACHING METHODS

Keeping students motivated is a challenge. Supplement the objectives by providing the "why," personal experiences, and current information. If you are going to teach the material in a group setting, prepare for the unit be deciding the best way to teach each objective and allow for student input.

If you are going to follow the plan for individualized instruction, provide opportunities that will allow each student to become involved in planning for and being responsible for his or her own education.

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected page and to indicate the correction on the copy. Mail this information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. .Please send corrections and recommendations for improving this publication to the following address:

Coordinator of Development
Curriculum and Instructional Materials Center
Oklahoma Department of Vocational and
Technical Education
1500 West Seventh Avenue
Stillwater, Oklahoma 74074-4364

For a free catalog, a list of new publications, or other instructional materials information call 1-800-522-5810, extension 589.

RESALE

BASIC SKILLS IN CURRICULUM

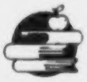
The CIMC has always been mindful of the importance of reinforcement (and sometimes remediation) of students' academic skills as they progress through vocational training, and has always included activities in its materials to enhance and promote use of these skills.

Recent state and federal legislation mandates vigorous basic skills development in vocational education in the wake of demands by industry that workers *must* be academically, as well as technically, competent, given the nature of the highly complex work place. In response, the CIMC has taken the following steps to document that, indeed, the instructional materials *do* combine academic skills training with the vocational training. In addition, concerted efforts have been made to "beef up," or enhance the basic skills instruction already present. Following is a brief description of those processes:

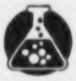
Basic Skills Icons and Enablers

To assist teachers and students in identifying activities that promote basic skills development, the CIMC has implemented a marking system that uses simple graphic symbols, or icons, and a list of specific tasks, or enablers, to identify the basic skill or skills that are called for in each job or assignment sheet.

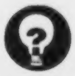
Each of the nine broad skills areas—reading, writing, mathematics, science, oral communication, interpersonal or relating, creative thinking and problem solving, employability, and social studies—is represented by the icon presented below.



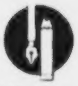
Reading



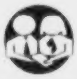
Science



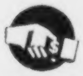
Creative Thinking/
Problem Solving



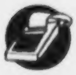
Writing



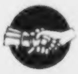
Oral Communication



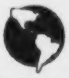
Employability



Math



Interpersonal or Relating



Social Studies

When an activity involving one of these basic skills is identified, the corresponding icon is placed in the left-hand margin of the job or assignment sheet. The basic skills training is further defined by retrieving the specific, or enabling, skill that is required by consulting a list of over two hundred and fifty enablers that has been compiled and grouped with each general basic skill. This enabling skill is placed directly below the icon.

As an example, an exercise that requires a student to conduct library research would make necessary the use of specific reading comprehension and research and reference skills. The basic skills that the exercise promotes would be depicted in the left-hand margin as follows:

ASSIGNMENT SHEET

PLANNING LIVING SPACE FOR HUMAN NEEDS 1

Name ______________________ Score __________

OBJECTIVE 10 **Define personal territory.**

INSTRUCTIONS

Reading Comprehension
- Gain factual information

Functional Reading
- Follow written instructions
- Use content area vocabulary

Language
- Use standard grammar, spelling, and capitalization
- State ideas clearly

- As discussed in Objective 1, each person has an invisible "space bubble" or comfort zone. A comfort zone is the space between oneself and others that brings a feeling of well-being. When one's comfort zone is crowded or invaded, discomfort often results. Therefore, personal territory needs should be a prime consideration when planning living space.
- For each of the following situations, draw your estimated comfort zone around the figures provided.
- Indicate how many inches from your body the comfort zone extends.
- Consider how that comfort zone changes in different situations. Answer the questions that follow.

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Basic Skills Documentation Matrix

Another component of the CIMC basic skills instructional plan is the "Basic Skills Documentation Matrix." The matrix graphically summarizes the basic skills training included in the vocational program, unit by unit. It should be helpful to teachers in planning their instruction, and to administrators as documentation that basic skills **are** being addressed during the vocational training.

The matrix for this publication is included as an 8½" by 11" foldout in this *Instructor's Manual.*

Matrices have been developed for most CIMC publications. For more information on those available for other programs, call the CIMC at 1-800-654-4502.

Instructional Supplement

The supplement is a tool for the instructor to use in helping students apply the basic skills in Assignment Sheets and Job Sheets. Some supplements are appropriate for use with all students; some are for use only with those students who do not understand the academic skills called for in the exercise.

MEASURING STUDENT PERFORMANCE GAINS

When you examine this book, you will notice that separate written pretests are no longer included in the units of instruction. Each CIMC unit now contains only a single Written Test. This test should be used as **both** pretest and posttest by giving it once before students start a unit and again when they have completed the unit.

The reason for using a single instrument as both pretest and posttest is so that direct comparison of each student's competencies before and after instruction can be made accurately. This comparison enables precise calculation, documentation, and evaluation of student **performance gains**.

Accurate performance gains analysis is an important requirement of the new Carl Perkins legislation for vocational education. Teachers can make an important contribution to the performance accountability mandated by the new federal legislation by carrying out accurate performance gains analysis for their students, and making this data available to students, parents, and administrators.

This analysis is easy to do and requires only simple calculations and record keeping. Detailed information regarding performance gains analysis is contained in the CIMC publication, *Measuring Learning & Competency Gains: The Pretest/Posttest Approach.* In addition, the CIMC has developed a computer program, CARL, which will perform all necessary calculations and will print out a record form of all information required for gain score analysis. Copies of CARL and the publication are available through your local testing liaison (in Oklahoma), or from the CIMC at 1-800-654-4502.

REQUIRED CRITERIA FOR A COMPETENCY-BASED EDUCATION PROGRAM

Criterion	Discussion	CIMC component meeting criterion
1. Instruction is based on clearly-stated learning objectives that are: a) observable and measurable, and b) communicated in writing to students before instruction begins.	Learning objectives drive CBE. Objectives are the "competencies" that learners must achieve. Each objective must clearly state what *learners* must *do* to demonstrate acquired skill or knowledge. Verbs in learning objectives are active and precise, stating the exact performance expected of learners. The objectives should also specify the standard or level of performance required. Objectives can be at any level of Bloom's Taxonomy and can include the cognitive, psychomotor, and affective domains. Higher-order cognitive skills should be included.	Objective Sheet
2. Instruction is aligned with the stated learning objectives	In CBE, the objectives specify what is taught. "Content" should relate to one or more objectives. The curriculum should cover all objectives with relevant information.	Information Sheet
3. There is a student evaluation system that is: a) criterion-referenced, and b) aligned to the learning objectives and the curriculum.	In CBE, the aim is to bring the performance of *all* learners up to a pre-defined standards and competencies. Learners work on each competency until they achieve "mastery"; the evaluation system should test and record this mastery. Learners can restudy and retest as often as needed. Specific remediation activities should also be available to learners when needed. The evaluation system focuses on what each student has achieved, not on what the instructor has "taught." The "constant" in CBE is student performance; the "variables" are time and resources. (This differs from traditional systems where learners get one chance at mastery; some succeed and some fail. In such systems, time and resources are constant and student achievement is variable.) If an evaluation is criterion-referenced, successful learner performance is defined by (or *referenced* to) mastery of pre-set objectives and standards (or *criteria*): there must be a careful match (or *alignment*) between what the student should master (objectives), what is taught (curriculum), and what is tested. Objectives, curriculum, and evaluation system must all match.	Written Test and Job Sheet/Skill Test

Criterion	Discussion	CIMC component meeting criterion
4. There is an observable management system of cognitive skill practice that provides for, promotes, and documents mastery learning.	For both cognitive and psychomotor skills, a CBE program must have a system of maintaining records of which skills and activities each learner has completed, which ones are in progress, and which ones have not yet been completed. Completion means "mastery"; no skill is completed until the learner has achieved the mastery level. The record system should promote feedback on student skill attainment to *both* instructor and learners, provide for remediation as needed, and encourage reevaluation of learner performance until mastery is achieved. Appropriate remediation strategies often should consider learning styles and other individual differences among learners. Learners should work on skills and activities until they achieve mastery. They should not be "passed on" without mastery. While learners may move ahead and work on other skills (i.e those for which all prerequisite skills have been mastered or those without prerequisites), work should also continue on the skills still requiring mastery. Students should not attempt higher-order skills until all prerequisite skills are mastered.	Assignment Sheet
5. There is an observable management system of psychomotor skill practice that provides for, promotes, and documents mastery learning.		Job Sheet/Skill Test
6. Skill mastery records are maintained for each learner, and learners have access to and make use of these records to monitor their skill acquisition.	Records should clearly indicate the skills each learner has mastered. One such record should profile or list the competencies that have been mastered and those to be mastered. Other performance indicators can be added and kept in a portfolio for each learner. Learners should have ready access to their portfolios to monitor their own progress in skill mastery and competency attainment.	Competency Profile

CORRECTIONS AND SUGGESTIONS

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This information will be used to correct the publication before the materials are reprinted. To ensure that the material is updated on a timely basis, notify the CIMC of necessary corrections as soon as possible after discovering the error.

2 Fold downward

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Page: Comment:

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STILLWATER OK 74074-9907

OBJECTIVE SHEET

SHEET METAL MATERIAL

A I

INTRODUCTION

Sheet metal is light weight metal used for various applications in construction. The most common uses include flashing, ductwork, and vents.

Sheet metal workers must be able to identify the various types of metals and fasteners used in sheet metal construction.

PREREQUISITE

Fundamentals of Construction

UNIT OBJECTIVES

After completing this unit, the student should be able to identify and state uses of common sheet metal materials. The student will demonstrate these competencies by completing the assignment sheet, job sheet, and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to show the ability to:

1. Given a list of terms associated with sheet metal materials, match them to their correct definition.
2. Given a physical description, identify sheet metal types.
3. Given a list of metal types, choose the typical use or major characteristic.
4. Identify the common sheet metal interlocking methods and fastening hardware.
5. Given alternatives, select the correct safety rules for handling large sheets of metal.
6. Identify metals by sight and feel. (Assignment Sheet)
7. Lift and move a large sheet of metal using the proper safety rules. (Job Sheet)

SHEET METAL MATERIAL

PREPARATION

- Review unit and plan presentation.
- Order or obtain materials to supplement unit.
- Give an overview of the course, explaining the organization of the materials from the foundation to the finished house.
- Introduce unit.

DELIVERY

Objective 1: Given a list of terms associated with sheet metal materials, match them to their correct definition.

- Use the Information Sheet to discuss terms associated with sheet metal.

Objective 2: Given a physical description, identify sheet metal types.

- Ask students to identify the types of sheet metals from your description.

Objective 3: Given a list of metal types, choose the typical use or major characteristic.

- Use the tables provided in the Information Sheet to describe metal types and their characteristics.
- Let students examine samples so they can see and feel the differences.

Objective 4: Identify the common sheet metal interlocking methods and fastening hardware.

- Show students some ductwork and point out the method used to interlock sheet metal.
- Explain that other methods and fastening hardware are used with sheet metal.

- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.
- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.
- Give the written test.

  NOTE: The written test may be given in sections if desired.

- Complete appropriate sections of competency profiles.
- Reteach and retest if necessary.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

SUGGESTED RESOURCES

AGC Videos

- *Hand Protection*
- *Foot Protection*

Available from Associated General Contractors, 1957 E. Street, N.W., Washington, D.C. 20006.

UNIT REFERENCES

- Jones, Leonard and Morse, Otto. *Sheet Metal Basics.* Mid-America Vocational Curriculum Consortium, Inc.: Stillwater, OK. 1983.
- Toenjes, Leonard P. *Building Trades Dictionary.* American Technical Publishers: Homewood, IL.

INFORMATION SHEET

SHEET METAL MATERIAL A 1

OBJECTIVE 1

Given a list of terms associated with sheet metal materials, match them to their correct definition.

- **alloy** — metal made by combining two or more metals
- **annealing** — process of softening and removing stress from metals by heating, then slowly cooling them
- **cold-rolled** — steel formed from hot-rolled steel cooled to room temperature; it is rolled to give it springiness or other tempering characteristics; has more precision forming than hot-rolled steel and costs a little more
- **ductwork** — a system of ducts, usually made of sheet metal, that distribute air within a structure (Figures 1 and 2)

FIGURE 1

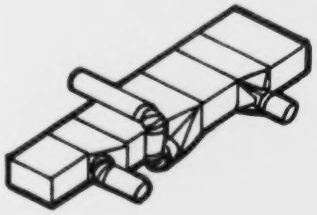
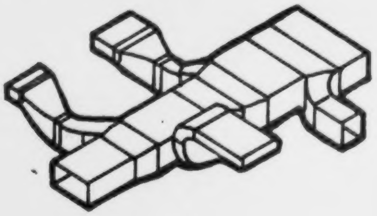


FIGURE 2



- **electroplate** — a process that uses an electrical current to form a coating of one metal over a base of another
- **extruded** — metal or plastic that has been forced through a special die to extend, form, and reshape it
- **ferrous metals** — metals having iron or steel content

- **flashing** — strips of sheet metal or plastic that are installed around openings and wall intersections to prevent water entry into a structure (Figures 3 and 4)

FIGURE 3

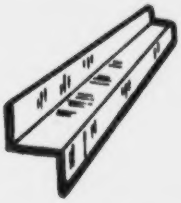
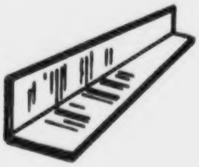
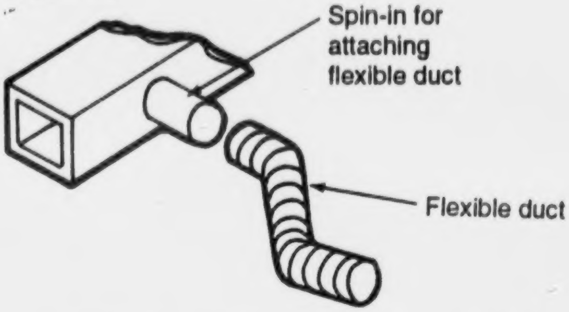


FIGURE 4



- **flexible duct** — round shaped duct material designed to allow easy shaping

FIGURE 5



NOTE: Flexible ducts are not recommended for lengths over 8′.

- **galvanneal** — mixture of molten zinc, steel, and iron used to coat a base of iron or steel
- **hot-rolled** — steel formed while it is white hot out of a blast furnace; it is rolled to reduce thickness, increase length, and produce sheets or rolls
- **malleable** — metal that can be easily shaped or formed
- **non-ferrous metals** — metals having no iron or steel content
- **sheen** — brightness or shininess

OBJECTIVE 2 **Given a physical description, identify sheet metal types.**

- Metals and ways to identify them by sight and feel
  - Galvanized iron — has a high sheen and presents a flaky-patterned surface appearance; usually thin and flexible
  - Black iron — bluish gray to dull gray; ranges from flexible to very rigid and is uncoated
  - Aluminum — has a silvery, smooth finish with a medium sheen; usually thin, soft, and flexible
  - Stainless steel — has a chrome-colored, smooth finish, frequently with a satin-like appearance; usually thin and flexible, yet hard
  - Paint grip iron — has a dull gray color; usually thin and flexible
  - Brass — has a yellowish color; usually rigid but readily malleable
  - Copper — has a reddish-brown color; usually soft and flexible
  - Zinc — has a bluish gray color; rigid and brittle

OBJECTIVE 3 **Given a list of metal types, choose the typical use or major characteristic.**

- Metals most commonly used in sheet metal work (Table 1)

TABLE 1

Metal	Characteristics	Rust Resistance	Typical Uses
Galvanized iron	Hot-rolled metal dipped in hot galvanneal	Excellent	Duct work, roof metal, blow pipes, and general sheet metal work
Black iron	Cold-rolled is harder and more expensive; hot-rolled is softer, less expensive and used more; easier to weld than galvanized	None; must be painted when job is finished	Service truck tool boxes, heat exchangers, horse trailers, and generally in applications requiring added strength
Aluminum	Has a protective coating of oxide film; smooth or decorative finishes or a highly polished anodized finish; usually light weight and easy to handle	Excellent	Gravel guard and fascia, finish siding for campers and mobile homes, and airplane fabrication; extruded for roofing and other applications
Stainless Steel	A steel alloyed with nickel and chromium; durable, and polished to various degrees	The best of all materials	labs, hospitals, meat packing plants, restaurants, and applications where cleanliness and attractiveness are required

Metal	Characteristics	Rust Resistance	Typical Uses
Paint Grip Iron	A cold-rolled iron electroplated with a zinc process and ready to paint	Fair for a time but still requires paint	Sign work, roof metals, and general commercial construction

- Other metals used in sheet metal work (Table 2)

TABLE 2

Metal	Characteristics	Rust Resistance	Typical Uses
Brass	Made by melting copper and zinc together; comes in a thin sheet called shim stock	Excellent	Automotive shops, etched decorative plaques, trophies, brass rods for brazing, and many ornamental and decorative applications
Copper	Attractive metal, but tarnishes easily; comes in wire, tube, and sheet; soft and easy to work with	Excellent	Roofing flashings, counter flashings, and many other roofing applications; electrical wiring, refrigeration and plumbing piping, and many decorative applications
Zinc	Usually used as an alloy or a coating for other metals	Excellent, but will tarnish	Additive to cut acids and as coatings for other metals

Metal	Characteristics	Rust Resistance	Typical Uses
Expanded Metal	Made from flat steel sheet run through a stamping machine, then stretched to leave it full of diamond-shaped holes	None; must be painted when job is finished	Belt guards, catwalks, and protective guards for the back windows of pickups and trucks
Decorative Metal	Stamped with various punch patterns to create attractive designs, usually made from aluminum plate and available in many lively colors	Excellent	Return air openings, shelf work, and many ornamental and decorative applications

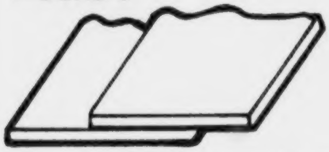
OBJECTIVE 4

Identify the common sheet metal interlocking methods and fastening hardware.

- Sheet metal interlocking methods that use no fasteners

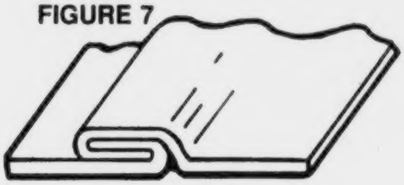
  — Lap joints

FIGURE 6



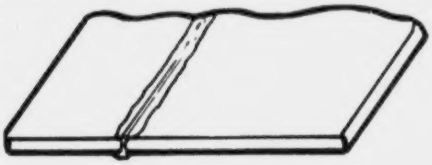
  — Lock seam

FIGURE 7



  — Welded or soldered joint

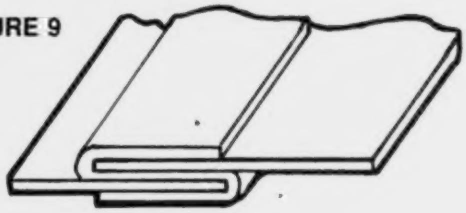
FIGURE 8



- Sheet metal fastening hardware

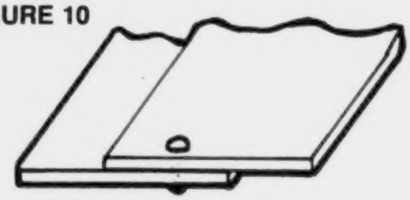
  - "S" cleat or clip

FIGURE 9



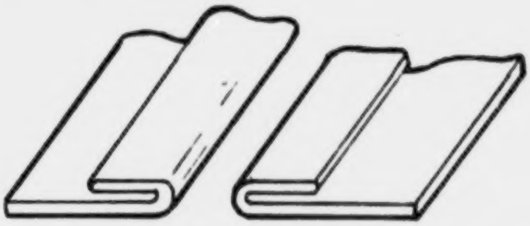
  - Riveted joint

FIGURE 10



  - Spline joint

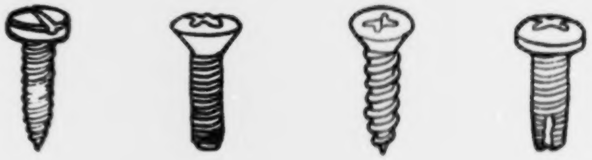
FIGURE 11



NOTE: The spline joint is held by a drive clip that is hammered onto the preformed edges of the duct.

- Screws

FIGURE 12



NOTE: These screws are also available in hex heads to allow use of sockets.

OBJECTIVE 5

Given alternatives, select the correct safety rules for handling large sheets of metal.

- Safety rules for moving large sheets of metal by hand
  - Wear appropriate personal protection equipment such as gloves, hard hat, and safety shoes.
  - Be especially careful to avoid accidents when transporting outdoors during high winds.
  - Know the exact area where the sheet will be moved and ensure it is cleared.
  - Have another student or co-worker help; *never* attempt to move a large sheet of metal by yourself.
  - Use locking pliers as handles; adjust both sets of pliers to proper locking pressure before starting to lift or move the sheet.

- Get a firm grip on the metal sheet; *do not* attempt to move until you're sure the sheet will not slip.

CAUTION: Because many sheet metals are treated with oil, they must be gripped firmly whether stacked flat or standing in a rack. If the sheet slips away at the very beginning, it poses a safety hazard to the workers moving it and could easily be damaged or damage sheets below or beside it.

- Move sheet so that locking pliers can be placed at each end of the sheet to provide a center of balance.
- Clamp locking pliers into position on each end of the sheet.
- Lift sheet to a safe distance off the floor, and with both workers on the same side of the sheet, carry it to the work area.
- Place the sheet down slowly or secure it in the work area before releasing the locking pliers.
- After cutting the proper working size, return metal to rack to ensure that fellow workers are not injured by metal protruding over edge of work bench.

Galvanized Carbon Steel Sheets

Gauge #	Lbs Per Sq Ft (Approximate)	Thickness Equivalent	Thickness Range in Inches
8	7.03125	0.1681	.1756-.1607
9	6.40625	0.1532	.1606-.1458
10	5.78125	0.1832	.1457-.1308
11	5.15625	0.1233	.1307-.1159
12	4.53125	0.1084	.1158-.1009
13	3.90625	0.0934	.1008-.0860
14	3.28125	0.0785	.0859-.0748
15	2.95875	0.0710	.0747-0.673
16	2.65625	0.0635	.0672-.0606
17	2.40625	0.0575	.0605-.0546
18	2.15626	0.0516	.0545-.0486
19	1.90525	0.0456	.0485-.0426
20	1.65626	0.0396	.0425-.0382
21	1.53125	0.0366	.0381-.0352
22	1.40625	0.0336	.0351-.0322
23	1.28125	0.0306	.0321-.0292
24	1.15625	0.0276	.0291-.0262
25	1.03125	0.0247	.0261-.0232
26	0.90625	0.0217	.0231-.0210
27	0.84375	0.0202	.0209-.0195
28	0.78125	0.0187	.0194-.0180
29	0.71875	0.0172	.0179-.0165
30	0.65625	0.0157	.0164-.0150
31	0.59375	0.0142	.0149-.0138
32	0.56250	0.0134	.0137-.0131

Carbon Steel and Brass Sheets

Carbon Steel		
USS Gauge #	Thickness Equivalent	Lbs Per Sq Ft (Approximate)
1	.28125	11.250
2	.26562	10.620
3	.2391	10.000
4	.2242	9.375
5	.2092	8.750
6	.1943	8.125
7	.1793	7.500
8	.1644	6.875
9	.1494	6.250
10	.1345	5.625
11	.1196	5.000
12	.1046	4.375
13	.0897	3.750
14	.0747	3.125
15	.6073	2.812
16	.0598	2.500
17	.0538	2.250
18	.0478	2.000
19	.0418	1.750
20	.0359	1.500
21	.0329	1.375
22	.0299	1.250
23	.0269	1.125
24	.0239	1.000
25	.0209	.875
26	.0179	.750
27	.0164	.687
28	.0149	.625
29	.0135	.526
30	.0120	.500

Brass		
American Gauge #	Thickness Equivalent	Lbs Per Sq Ft (Approximate)
1	.2893	12.75
2	.2576	11.35
3	.2294	10.11
4	.2043	9.002
5	.1819	8.015
6	.1620	7.138
7	.1443	6.358
8	.1285	5.662
9	.1144	5.041
10	.1019	4.490
11	.1907	3.997
12	.0808	3.560
13	.0720	3.173
14	.0641	2.825
15	.0571	2.516
16	.0508	2.238
17	.0453	1.996
18	.0403	1.776
19	.0359	1.582
20	.0320	1.410
21	.0285	1.256
22	.0254	1.119
23	.0226	.9958
24	.0201	.8857
25	.0179	.7887
26	.0159	.7006
27	.0142	.6257
28	.0126	.5552
29	.0113	.4979
30	.0100	.4406

Copper and Zinc Sheets

Copper		
Gauge #	Thickness Equivalent	Lbs Per Sq Ft (Approximate)
1	.300	13.94
2	.284	13.20
3	.259	12.04
4	.238	11.07
5	.220	10.22
6	.203	9.420
7	.180	8.360
8	.165	7.660
9	.148	6.875
10	.134	6.225
11	.120	5.575
12	.109	5.065
13	.095	4.410
14	.083	3.860
15	.072	3.338
16	.065	3.020
17	.058	2.695
18	.049	2.280
19	.042	1.952
20	.035	1.627
21	.032	1.484
22	.028	1.302
23	.025	1.162
24	.022	1.022
25	.020	.928

Zinc		
Gauge #	Thickness Equivalent	Lbs Per Sq Ft (Approximate)
24	.125	4.70
23	.100	3.75
22	.090	3.37
21	.080	3.00
20	.070	2.62
19	.060	2.25
18	.055	2.06
17	.050	1.87
16	.045	1.68
15	.040	1.50
14	.036	1.35
13	.032	1.20
12	.028	1.05
11	.024	.90
10	.020	.75
9	.018	.67
8	.016	.60
7	.014	.52
6	.012	.45
5	.010	.37
4	.008	.30
3	.006	.22
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TM 4

Stainless Steel Sheets

Thickness Ordering Range in Inches	Gauge #	Thickness Equivalent	Lbs Per Sq Ft (Approximate) Cold Rolled
.161 to .176	8	.17187	7.2187
.146 to .160	9	.15625	6.5625
.131 to .145	10	.140625	5.9062
.115 to .130	11	.125	5.5200
.009 to .114	12	.109375	4.5937
.084 to .098	13	.09375	3.9374
.073 to .083	14	.078125	3.2812
.066 to .072	15	.0713125	2.9521
.059 to .065	16	.0625	2.6250
.053 to .058	17	.05625	2.3625
.047 to .052	18	.050	2.1000
.041 to .046	19	.04375	1.8375
.036 to .040	20	.0375	1.5750
.033 to .035	21	.034375	1.4437
.030 to .032	22	.03125	1.3125
.027 to .029	23	.028125	1.1813
.024 to .026	24	.025	1.0500
.0199 to .023	25	.021875	0.9187
.0178 to .0198	26	.01875	0.7875
.0161 to .0177	27	.0171875	0.7218
.0146 to .0160	28	.015625	0.6562
.0131 to .0145	29	.0140625	0.5906
.0115 to .0130	30	.0125	0.5250
.0105 to .0114	31	.0109375	0.4594
.0095 to .0104	32	.01015625	0.4265

Aluminum Sheets

Thickness and Size. Inches	Mill Finish							
	1100		3003		5052			5086
	-0	-H14	-0	-H14	-0	-H32	-H34	-H32
.190 x 36 x 96				X*		X		
48 x 120				X*				
48 x 144		X		X*	X	X*		
60 x 144				X*				
.160 x 48 x 144						X		
.125 x 36 x 96	X			X		X*		
48 x 96				X*		X*		
48 x 120				X*				
48 x 144		X	X	X*	X	X*	X*	X
60 x 144				X*		X*		
.100 x 48 x 144						X*		
.090 x 36 x 96						X*		
48 x 96						X		
48 x 144					X	X*	X*	
.080 x 48 x 96						X		
48 x 144						X*	X	
.063 x 36 x 96		X						
48 x 96						X*		
48 x 144					X	X*	X	
60 x 144				X				
.050 x 48 x 144						X*		
.040 x 48 x 144						X		
.032 x 48 x 144						X		

X — Standard items

X* — Plant stocks available

O — Indicates sheet has been annealed

H — Indicates sheet has been strain-hardened

NOTE: The digit 1 following the letter H means sheet has been strain-hardened only, or subjected to stress to improve strength and hardness. Second digit indicates hardness on a scale of 0 to 7, so a 3003-H14 indicates the sheet has been strain-hardened only and is medium hard. The 3003-H14 aluminum sheet is the most commonly used sheet in the industry.

ASSIGNMENT SHEET

SHEET METAL MATERIAL **A 1**

Name ______________________________ Score __________

OBJECTIVE 6 **Identify metals by sight and feel.**

INTRODUCTION

Sheet metal workers must be able to identify the kinds of metals they are working with. This assignment sheet will give you practice in recognizing various kinds of metal by their appearance and feel.

EQUIPMENT AND SUPPLIES

- Metals of various kinds

INSTRUCTIONS

Your instructor will arrange on a work bench ten different metals with numbers attached to each. Determine by sight and feel what each metal is and complete the following worksheet. Be sure to complete your reasons for naming each metal by indicating whether your conclusion was based on the color of the metal, the texture or feel of the metal, or both.

Functional Reading
- Follow written instructions

Functional Writing
- Complete forms and records

Physical Science
- Analyze/classify matter

1. Metal #1 is: _______________. Reasons: _______________
____
2. Metal #2 is: _______________. Reasons: _______________
____
3. Metal #3 is: _______________. Reasons: _______________
____
4. Metal #4 is: _______________. Reasons: _______________
____

Cognitive Activities

- Select an alternative

5. Metal #5 is: ______________. Reasons: ______________

____

6. Metal #6 is: ______________. Reasons: ______________

____

7. Metal #7 is: ______________. Reasons: ______________

____

8. Metal #8 is: ______________. Reasons: ______________

____

9. Metal #9 is: ______________. Reasons: ______________

____

10. Metal #10 is: ______________. Reasons: ______________

____

ASSIGNMENT ANSWERS

SHEET METAL MATERIAL

A 1

ASSIGNMENT SHEET 1

Evaluated to the satisfaction of the instructor.

JOB
SHEET

SHEET METAL MATERIAL A 1

OBJECTIVE 6

Lift and move a large sheet of metal using the proper safety rules.

INTRODUCTION

This exercise provides you practice in safely moving a large sheet of metal. Sheet metal often have sharp or ragged edges that can cause painful cuts when not handled carefully.

TOOLS AND EQUIPMENT

- Sheet metal as selected by instructor
- Two pairs of locking pliers
- Leather gloves
- Hard hat
- Safety shoes

PROCEDURE

	Yes	No
1. Put on safety equipment.	___	___
2. Select a co-worker or fellow student to assist.	___	___
3. Determine the work area to which the sheet of metal is to be moved and clear area.	___	___
4. Adjust both locking pliers so that they will firmly grip the metal.	___	___
5. Work as a team of two and lift or move the sheet of metal to a point that the locking pliers can be applied and secured on each end at a point of balance.	___	___

Functional Reading
- Follow written instructions

General Relating
- Interact with co-workers

Job Acquisition/ Development
- Master specific job task/procedure

Yes No

6. Stay on the same side of the sheet metal as your co-worker and use the locking pliers as handles to lift the sheet metal off the floor. ___ ___

7. Carry the sheet metal to the selected work area. ___ ___

NOTE: If you have selected a good center of balance, the sheet metal may lean slightly onto the shoulder of each worker.

8. Set the sheet metal down and position it in the work area. ___ ___

9. Remove the locking pliers. ___ ___

10. Inspect the sheet metal for any damage. ___ ___

11. Have your instructor check the sheet metal. ___ ___

12. Return tools to proper storage area. ___ ___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS ______________________________

____

____

votech

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Used safety equipment	4	3	2	1
Pliers firmly locked	4	3	2	1
Point of balance located properly	4	3	2	1
No damage to sheet metal	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** Can perform job with no additional training
3 **Moderately Skilled** Has performed job during training program; limited additional training may be required
2 **Limited Skill** Has performed job during training program; additional training is required to develop skill
1 **Unskilled** Is familiar with process, but is unable to perform job

WRITTEN TEST

SHEET METAL MATERIAL

A 1

Name ______________________________ Score ________

OBJECTIVE 1

Given a list of terms associated with sheet metal materials, match them to their correct definition. Write the letter that corresponds to the most correct answer.

_____ 1. A metal or plastic that has been forced through a special die to extend, form, or reshape it is

- a. annolized
- b. sheened
- c. extruded
- d. plated

_____ 2. Metals having iron or steel content are called

- a. ferrous metals
- b. non-ferrous metals
- c. alloys
- d. ore

_____ 3. A metal made by combining two or more metals is

- a. extruded mix
- b. an alloy
- c. malleable metal
- d. ferrous metal

_____ 4. Another term for the brightness or shininess of a metal is its

- a. galvanneal
- b. plate gloss
- c. texture
- d. sheen

May be photocopied for student use.

_____ 5. Metals that have NO iron or steel content are called

a. ferrous metals
b. malleable metals
c. alloys
d. non-ferrous metals

_____ 6. A process that uses an electrical current to coat one metal over the base of another is

a. annealing
b. electroplating
c. electro-sheen
d. galvanneal

_____ 7. Metal that can be easily shaped or formed is

a. malleable
b. extruded
c. cold-rolled
d. flexiplated

_____ 8. Steel formed in sheets with a roller right out of a furnace is

a. cold-rolled steel
b. hot-formed steel
c. hot-rolled steel
d. galvanneal steel

OBJECTIVE 2 **Given a physical description, identify sheet metal types.**

_____ 1. What is a metal with a silvery, smooth finish with a medium sheen; usually thin, soft, and flexible?

a. Aluminum
b. Stainless steel
c. Brass
d. Zinc

May be photocopied for student use.

_____ 2. Which of the following metals has a dull gray color; usually thin and flexible?

a. Brass
b. Zinc
c. Paint grip iron
d. Galvanized iron

_____ 3. A metal with a yellowish color; usually rigid but readily malleable is

a. Brass
b. Copper
c. Black iron
d. Aluminum

_____ 4. A metal that has a bluish gray color and is rigid and brittle is

a. cast iron
b. black iron
c. blue steel
d. zinc

_____ 5. What is a metal with a reddish-brown color and is usually soft and flexible?

a. Red iron
b. Brass
c. Aluminum
d. Copper

OBJECTIVE 3

Given a list of metal types, choose the typical use or major characteristic.

_____ 1. What is the metal used in labs, hospitals, and restaurants, where cleanliness and attractiveness is required?

a. Aluminum
b. Stainless steel
c. Paint grip iron
d. Zinc

May be photocopied for student use.

_____ 2. What is a typical use of brass?

a. Roof flashing
b. Sign work
c. Ornamental
d. Exchangers

_____ 3. The major characteristic of stainless steel is

a. Rust resistance
b. Easy to paint
c. Malleable
d. Light weight

_____ 4. A typical use for galvanized iron is

a. finish siding
b. duct work
c. sign work
d. roofing

_____ 5. A common application for the use of black iron is for

a. finish siding
b. sign work
c. roofing flashing
d. heat exchangers

_____ 6. Zinc is used primarily as

a. a coating for other metals
b. sign work
c. a paint additive
d. electrical wiring

_____ 7. The major characteristic of copper is its

a. durable, polished shine
b. steel-like hardness
c. electroplated surface
d. softness and ease to work with

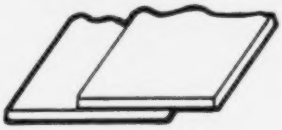
May be photocopied for student use.

_____ 8. What is the most typical use of aluminum?

a. Duct work
b. Ornamental applications
c. Camper and mobile home siding
d. Sign work that requires paint

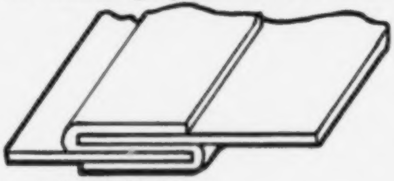
OBJECTIVE 4 **Identify the common sheet metal interlocking methods and fastening hardware.**

_____ 1. The figure below is referred to as a/an



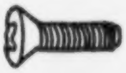
a. adhesive joint
b. welded joint
c. lap joint
d. riveted joint

_____ 2. The following figure is identified as a/an



a. riveted joint
b. welded joint
c. adhesive joint
d. "s" cleat

_____ 3. The sheet metal screw below is called a



a. sheet metal blunt
b. self-tapping
c. sheet metal gimlet
d. thread-cutting screw

May be photocopied for student use.

_____ 4. Which of the following fastening hardware types are NOT used to connect sheet metal?

a. Rivets
b. "P" clamps
c. Screws
d. Clips

OBJECTIVE 5 **Given alternatives, select the correct safety rules for handling large sheets of metal.**

_____ 1. Before moving a large sheet of metal ensure

a. you know the exact area where the sheet is to be moved
b. you have cleared the area
c. you wear appropriate personal safety equipment
d. all the above

_____ 2. To transport the sheet you must

a. lock pliers on each end as handles
b. ask a co-worker to get on the opposite side of the sheet
c. lock the pliers near the bottom of the sheet
d. all the above

_____ 3. When transporting large sheets of metal outdoors, you should

a. apply oil to the metal surface
b. clamp the locking pliers near the top edge of the sheet
c. be especially careful to avoid accidents caused by wind
d. ask a co-worker to stand on the opposite side of the sheet

May be photocopied for student use.

_____ 4. The personal protection equipment recommended when handling large sheets of metal are

a. none required
b. gloves, hard hat, and face shield
c. gloves, hard hat, and safety shoes
d. gloves, safety shoes, and respirators

May be photocopied for student use.

SHEET METAL MATERIAL A 1

OBJECTIVE 1

1. c
2. a
3. b
4. d
5. d
6. b
7. a
8. c

OBJECTIVE 2

1. a
2. c
3. a
4. d
5. d

OBJECTIVE 3

1. b
2. c
3. a
4. b
5. d
6. a
7. d
8. c

OBJECTIVE 4

1. c
2. d
3. a
4. b

OBJECTIVE 5

1. d
2. a
3. c
4. c

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) INTRODUCTION TO SHEET METAL

UNIT NUMBER AND TITLE – A1 – SHEET METAL MATERIAL

TOTAL NUMBER OF TEST QUESTIONS 29

TOTAL NUMBER OF BASIC SKILL QUESTIONS 11

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-3, 5-7	S
1	4, 8	X
2	1-5	S
3	1-8	X
4	1-4	X
5	1-4	X

OBJECTIVE SHEET

SHEET METAL TOOLS

A 2

INTRODUCTION

With the many types of sheet metal available, it requires a wide range of tool types to measure, cut, drill, bend, and join them.

This unit will introduce you to the hand tools, bench tools, and power tools used in sheet metal construction.

PREREQUISITE

Fundamentals of Construction

UNIT OBJECTIVE

After completing this unit, the student should be able to identify and state the use of common tools. The student will demonstrate these competencies by completing the assignment sheets, and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to show the ability to:

1. Given a list of terms associated with sheet metal tools, match them to their correct definition.
2. Given drawings, match sheet metal tools to their use.
3. Identify common sheet metal bench tools.
4. Match drawings to the correct use of sheet metal power tools.
5. Given a list of sheet metal tools, match them to their correct use. (Assignment Sheet 1)
6. Provided with common sheet metal tools, identify them by their appearance. (Assignment Sheet 2)
7. Use a circumference rule to perform measurements. (Assignment Sheet 3)

SUGGESTED ACTIVITIES

SHEET METAL TOOLS

A 2

PREPARATION

- Review unit and plan presentation.
- Order or obtain materials to supplement unit.
- Give an overview of the course, explaining the organization of the materials from the foundation to the finished house.
- Introduce unit.

DELIVERY

Objective 1: Given a list of terms associated with sheet metal tools, match them to their correct definition.

- Discuss and demonstrate terms that may be unfamiliar to students.

Objective 2: Given drawings, match sheet metal tools to their use.

- Use the Information Sheet to discuss the use of sheet metal tools.

Objective 3: Identify common sheet metal bench tools.

- Display types of bench tools available within your area.
- Take a field trip to a sheet metal shop and identify as many bench tools as possible.

Objective 4: Match drawings to the correct use of sheet metal power tools.

- Use the Information Sheet to discuss the power tools.
- Explain that goggles and a hard hat are required before operating a power tool.

APPLICATION

Objective 5: Given a list of sheet metal tools, match them to their correct use. (Assignment Sheet 1)

Objective 6: Provided with common sheet metal tools, identify them by their appearance. (Assignment Sheet 2)

Objective 7: Use a circumference rule to perform measurements. (Assignment Sheet 3)

- Allow students to practice the procedures in the assignment sheets.

EVALUATION

Pretest

- Give written test as pretest.
- Determine individual study requirements from pretest results.
- Counsel students individually on pretest results and study requirements.
- Modify materials in unit or create supplementary materials for individual students as required.

Skill Test

- Evaluate students on assignment sheet activities.
- Evaluate students on job sheet activities.
- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.
- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.

- Give the written test.

  NOTE: The written test may be given in sections if desired.

- Complete appropriate sections of competency profiles.
- Reteach and retest if necessary.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

UNIT REFERENCES

- Jones, Leonard and Otto Morse. *Sheet Metal Basics.* Mid-America Vocational Curriculum Consortium, Inc.: Stillwater, OK.
- Toenjes, Leonard P. *Building Trades Dictionary.* American Technical Publishers, Inc.: Homewood, IL.

SHEET METAL TOOLS

OBJECTIVE 1

Given a list of terms associated with sheet metal tools, match them to their correct definition.

- **acceptable cutting technique** — the use of hand snips with such a degree of skill that cut edges are left smooth and clean and free of burrs or fishhooks
- **bench tools** — small, hand-operated tools generally anchored to a bench and used for one or more operations on cylindrical projects
- **blocking out** — cutting out by hand or on a square shear all the material required to complete a pattern
- **brakes** — machines for forming sheet metal
- **burrs or fishhooks** — irregular edges on sheet metal that turn up and roll into a fishhook shape resulting from improper use of cutting snips

CAUTION: Handle sheet metal carefully, as burrs and fishhooks can easily become lodged in fingers, causing a painful injury.

- **gauge** — thickness of sheet metal or diameter of wire; also a tool to measure that thickness
- **manual and power-operated floor tools** — medium to large tools that are usually secured in a permanent position for forming and working with sheet metal
- **Pittsburg lock** — type of sheet metal seam that is formed on a Pittsburgh machine and commonly used on rectangular ducts
- **portable power tools** — small, electrically or air-operated tools that can be comfortably moved from job to job
- **rolls** — machines for making cylindrical or rounded components

- **scribe** — to scratch on a piece of metal with another piece of metal to make a line or a pattern; also a tool for scratching on metal

- **stretchout** — the amount of material required to fabricate a given component not including seam or joint allowances

- **waste** — unusable metal remaining after a pattern has been cut

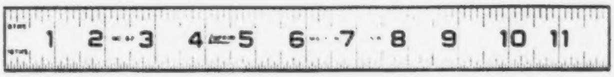
  NOTE: Waste is also known as *scrap*, and sometimes used in the expression "waste the metal" meaning to place it in the scrap pile.

OBJECTIVE 2 **Given drawings, match sheet metal tools to their use.**

- Measuring tools

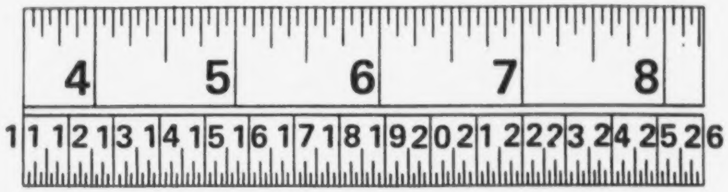
  — Steel rules — Used for measuring linear distances; graduated to $\frac{1}{16}$-inch; usually 24 inches, 36 inches, or 48 inches long; for critical measurements, some rules are graduated to $\frac{1}{64}$ inch. (Figure 1)

FIGURE 1



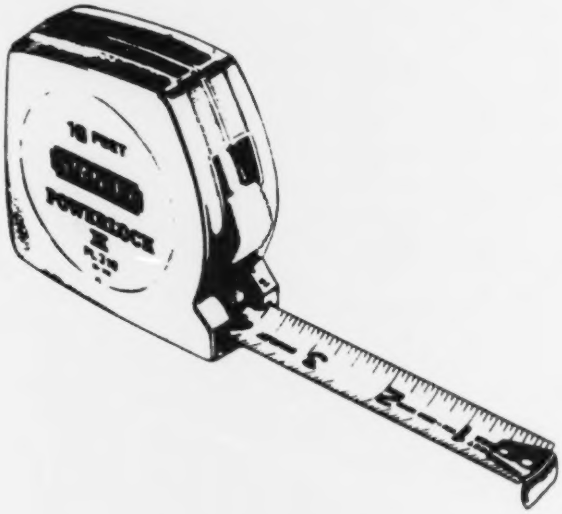
  — Circumference rules — Used to find the circumference of a circle when the diameter is known or the diameter of a circle when the circumference is known; also used as a straightedge and for other activities in layout work. The top rule can be used as a standard rule with $\frac{1}{16}''$ increments. (Figure 2)

FIGURE 2



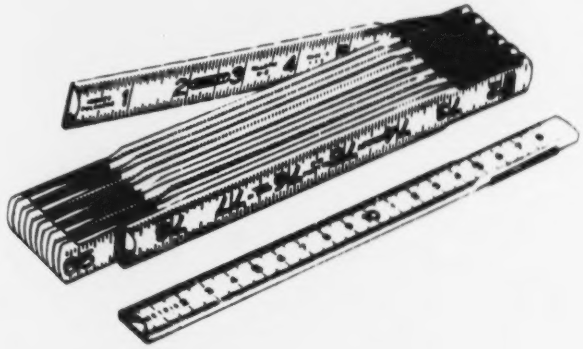
- Retractable steel tape rules — Take up little space, are handy to carry and easy to use; available in lengths form 6 feet to 25 feet and graduated to $\frac{1}{16}$ inch (Figure 3)

FIGURE 3



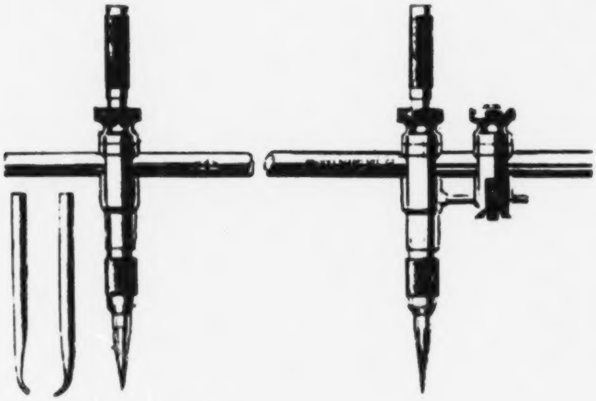
- Inside-reading folding rules — Commonly used in sheet metal work; usually 6 feet long and graduated to $\frac{1}{16}$ inch (Figure 4)

FIGURE 4



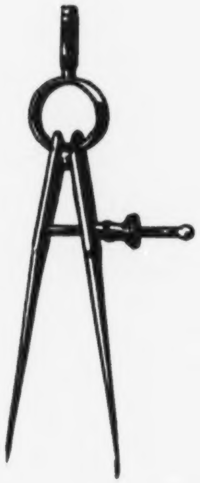
- Dividers
    - Trammel points — Used to mark large circles and arcs (Figure 5)

FIGURE 5



-
    - Wing dividers — Used to mark small circles and arcs and to transfer dimensions (Figure 6)

FIGURE 6

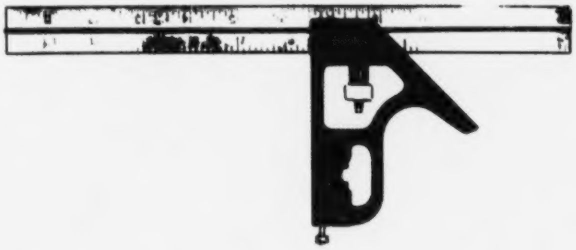


- Squares
  - Try squares — Used for accuracy in layout work; blades are available in 6-inch, 8-inch, 10-inch, and 12-inch lengths. (Figure 7)

FIGURE 7

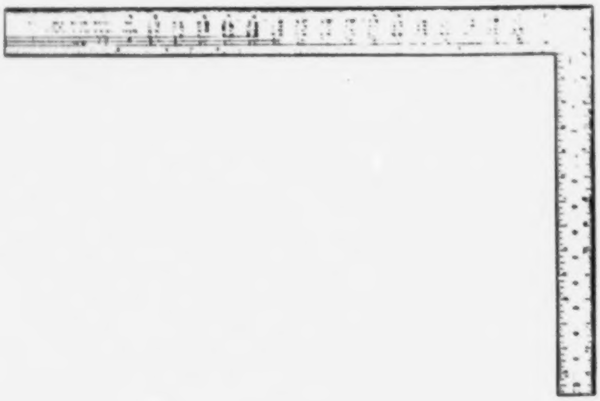
  - Combination squares — Used for layout accuracy with 45° and 90° angles (Figure 8)

FIGURE 8



- Framing squares — Used in layout work for accuracy because all layout must start from a square corner (Figure 9)

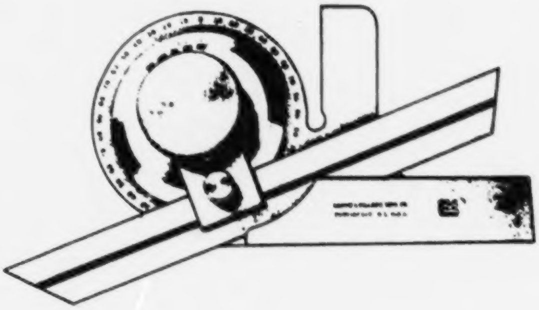
FIGURE 9



- Protractors

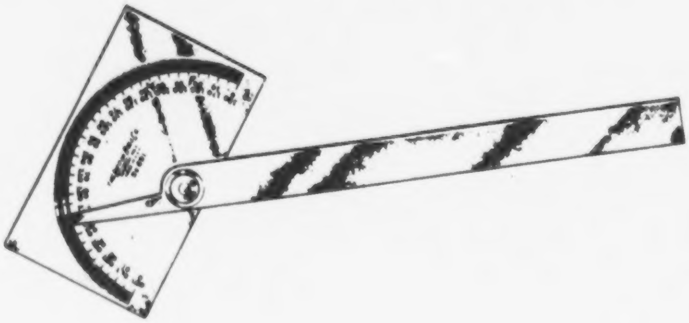
  - Bevel protractor — Used to find or construct angles of different degrees (Figure 10)

FIGURE 10



- Steel swinging-blade protractor — Used to find or construct angles of different degrees; lighter and easy to carry in a tool box (Figure 11)

FIGURE 11

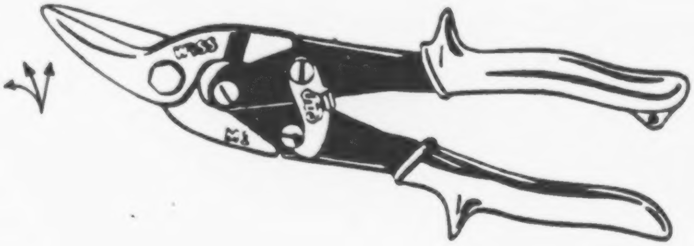


- Sheet metal snips

  NOTE: Do not use snips to cut wire or welding rods,a nd when snips are marked "stainless steel" use them *only* for cutting stainless.

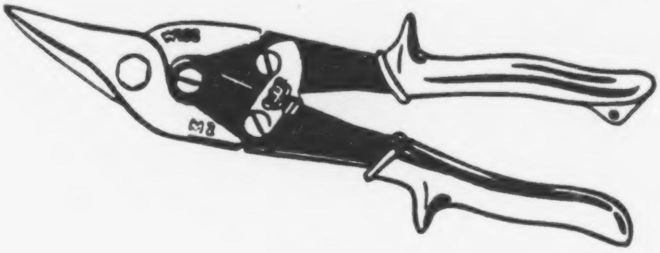
  - Left cut — Cuts to the left around curves and 90° corners (Figure 12)

FIGURE 12



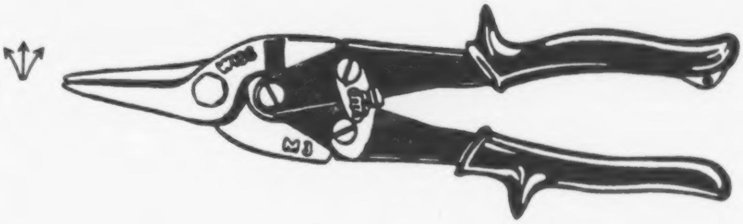
- Right cut — Cuts to the right around curves and 90° corners (Figure 13)

FIGURE 13



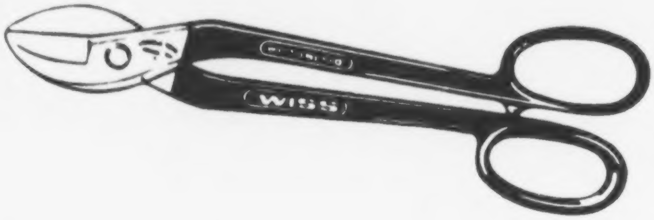
- Straight cut — Cuts straight lines or curves; one style has very short blades for special cutting needs (Figure 14)

FIGURE 14



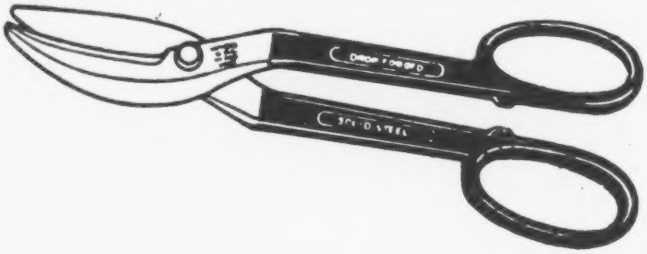
- Bulldog — Heavy duty snips used for all general cuts and thicker metals (Figure 15)

FIGURE 15



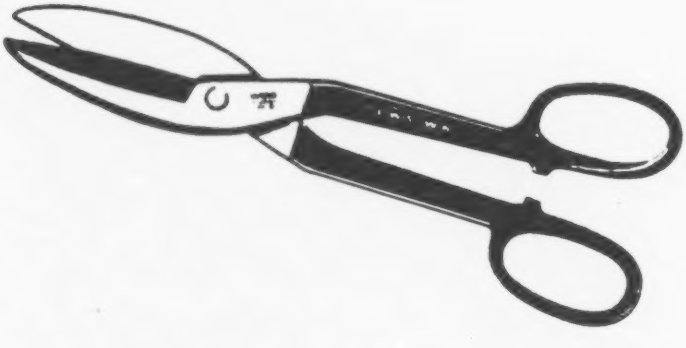
- Circular — For cutting inside circles and metal close to an obstacle (Figure 16)

FIGURE 16



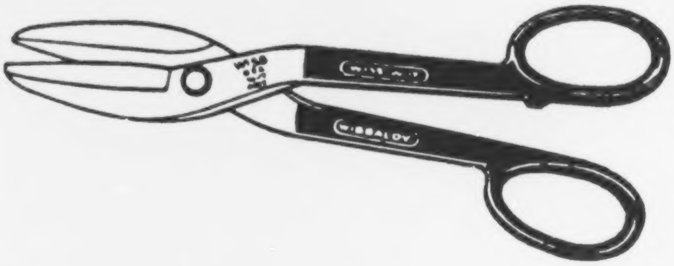
- Straight blade — Best for cutting straight lines (Figure 17)

FIGURE 17



- Combination blade — Will cut curves by letting the metal slide over the top blade with ease, and will also cut straight (Figure 18)

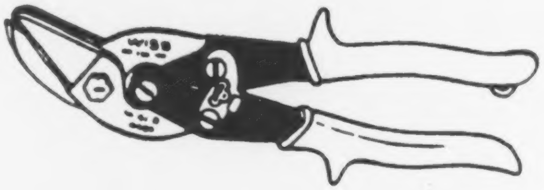
FIGURE 18



- Double cut — specifically designed to cut ⅛-inch wide slit in preformed metal duct (Figure 19)

  NOTE: Double cut snips minimize waste and time, and although normally used to cut round duct, can also be used on square or rectangular duct.

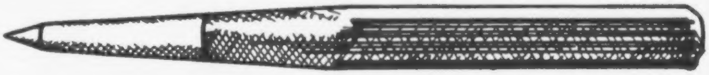
FIGURE 19



- Punches

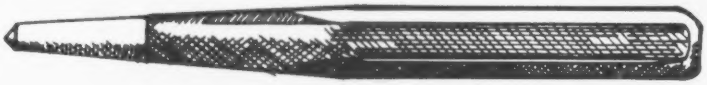
  - Prick punch — Used to make small dents or establishing points for trammel points and wing dividers; point is ground to approximately 30° (Figure 20)

FIGURE 20



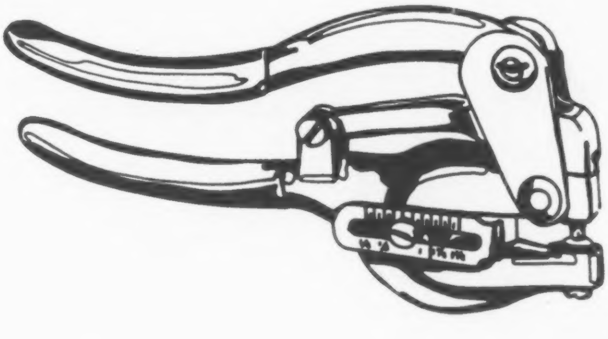
  - Center punch — Used for marking the location point and the center of holes to be drilled; the point is ground to approximately 90° (Figure 21)

FIGURE 21



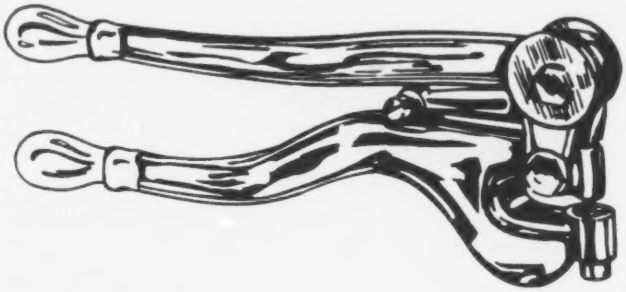
  - Hand punch — Used to punch small holes in light gauge metal; punches and dies range in size from 1/16 inch to 9/32 inch, and are easily changed (Figure 22)

FIGURE 22



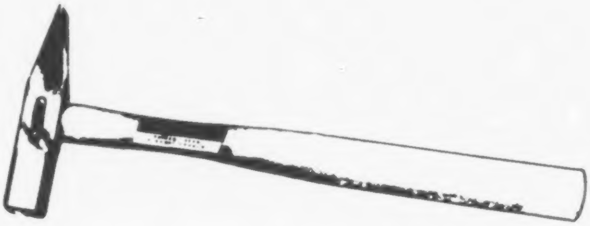
- Iron hand punch — Used on heavier gauge material; punches and dies range from 1/16 inch to 1/2 inch, and are easily changed (Figure 23)

FIGURE 23



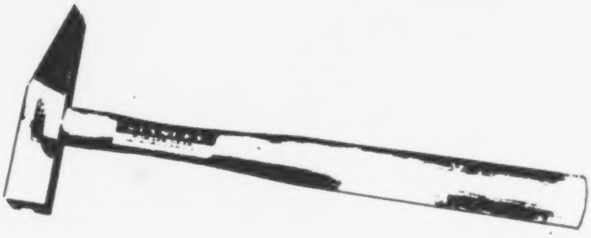
- Hammers
  - Riveting hammer — Has a slightly curved, square face and beveled edges to prevent marking metal as rivets are set (Figure 24)

FIGURE 24



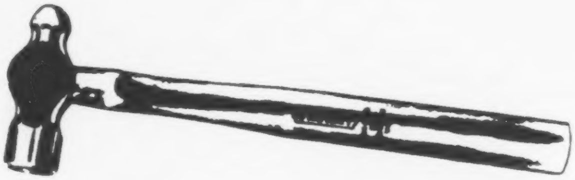
- Setting hammer — Has a square, flat face and flat sides for closing up a Pittsburgh lock seam (Figure 25)

FIGURE 25



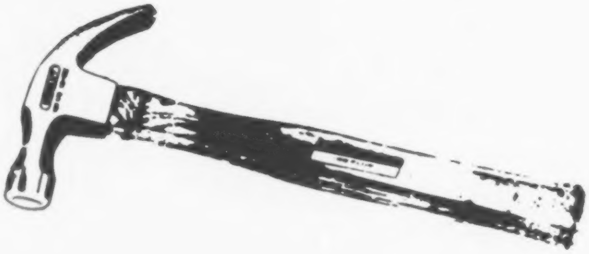
- Ball peen hammer — General purpose hammer with a curved face and round head (Figure 26)

FIGURE 26



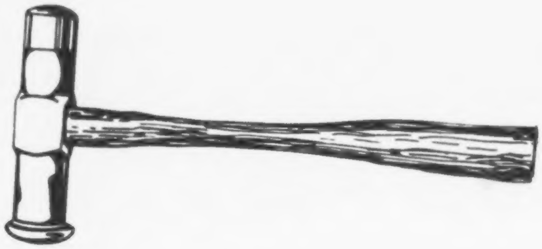
- Curved claw hammer — Not considered a sheet metal tool, but is found and used in almost all sheet metal shops (Figure 27)

FIGURE 27



- Body or raising hammer — Used mostly as a finish tool, in cornice work, and in stainless steel work. (Figure 28)

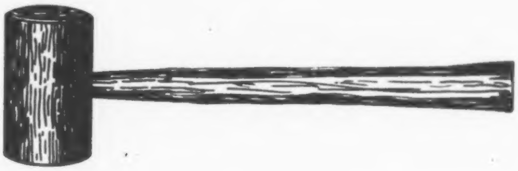
FIGURE 28



- Mallet — Made of good hickory or rawhide and used where a metal hammer would dent or damage material

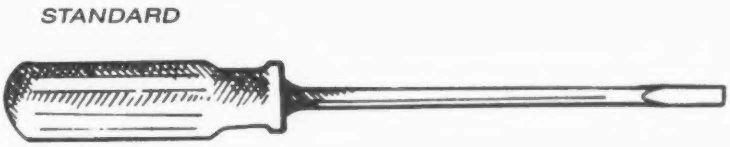
  NOTE: Only a mallet should be used on a brake.

FIGURE 29



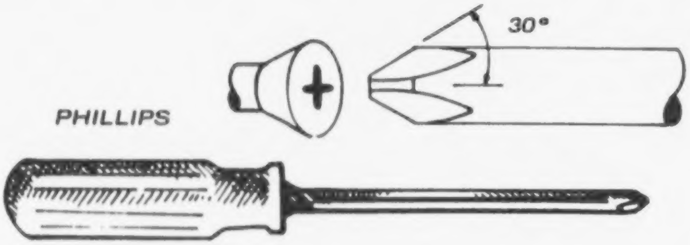
- Screwdrivers
  - Standard — Used on bolts and screws with straight-slot heads

FIGURE 30



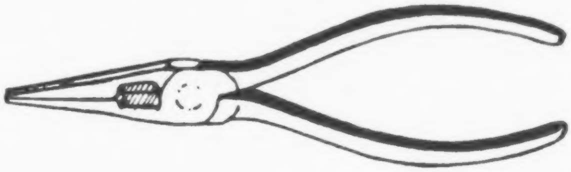
- Phillips — Used on bolts and screws with cross-slot heads

FIGURE 31



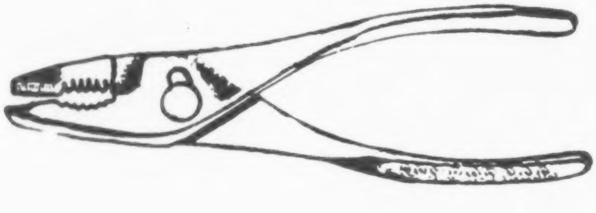
- Pliers
  - Long nose pliers — Long narrow nose for deeper reach into work area (Figure 32)

FIGURE 32



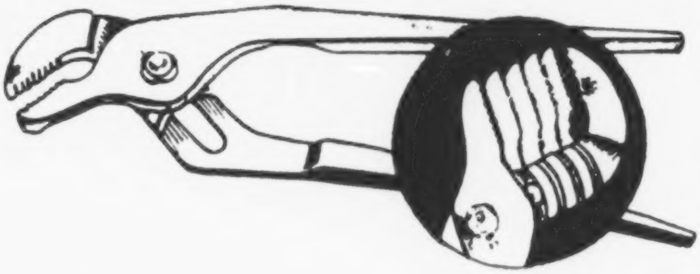
  - Combination pliers — For holding on object that is difficult to hold with ones hands; should *not* be used as a wrench for removing nuts (Figure 33)

FIGURE 33



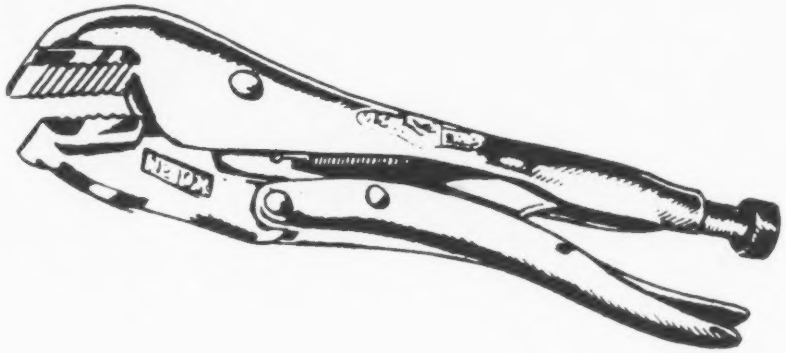
- Adjustable pliers — Jaws are positioned and locked into place by engaging tongue in proper groove; a series of channels give wide range of jaw openings; jaws should not slip, even under heavy pressure. These are also known as channel lock pliers. (Figure 34)

FIGURE 34



- Locking pliers — Pliers adjust easily to lock at any size with desired amount of pressure; release lever opens jaws; can also be used as nonlocking pliers. These are also known as vise grips. (Figure 35)

FIGURE 35



- Metal marking devices

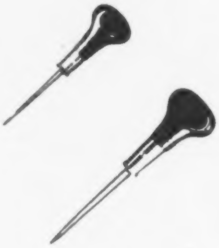
CAUTION: Metal-marking devices can cut your hand easily, so use them with care.

- Scratch gage — Used to scribe lines on metal using the edge of the metal as a straightedge, but can be used in many ways depending on type (Figure 36)

FIGURE 36

- Scratch awl — Used to scribe lines on metal in sheet metal layout; used with a guide (Figure 37)

FIGURE 37

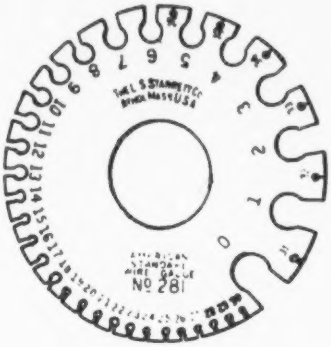


- Gauges

  — American standard wire gauge — Used for measuring the thickness of sheets and wire diameter made of nonferrous metals such as copper, brass, and aluminum (Figure 38)

  NOTE: The American standard wire gauge is sometimes called a *Brown and Sharpe* gauge.

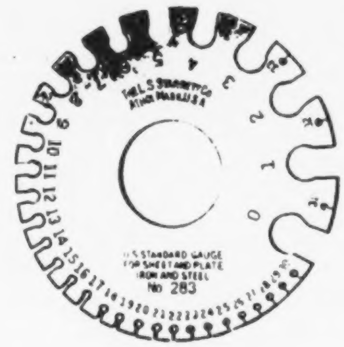
FIGURE 38


0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
WIRE GAUGE
Nº 281

  - U.S. standard gauge — Used for measuring uncoated sheet, plate iron and steel; based on weights in ounces per square foot (Figure 39)

    NOTE: There are specialty gauges such as the English standard wire gauge, but the American and U.S. standard gauges are most frequently used in sheet metal work.

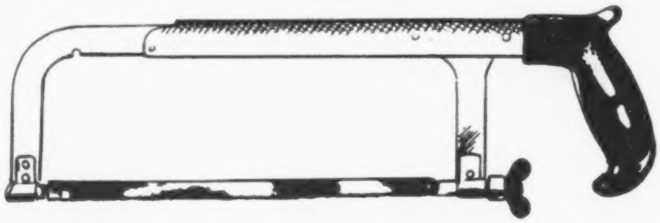
FIGURE 39


U.S. STANDARD GAUGE
FOR SHEET AND PLATE
IRON AND STEEL
No 283

- Miscellaneous hand tools

  - Hacksaw — Used to cut various types of metal (Figure 40)

FIGURE 40



- File — Used to remove burrs, to square the end s of band iron, and to straighten uneven edges (Figure 41)

FIGURE 41

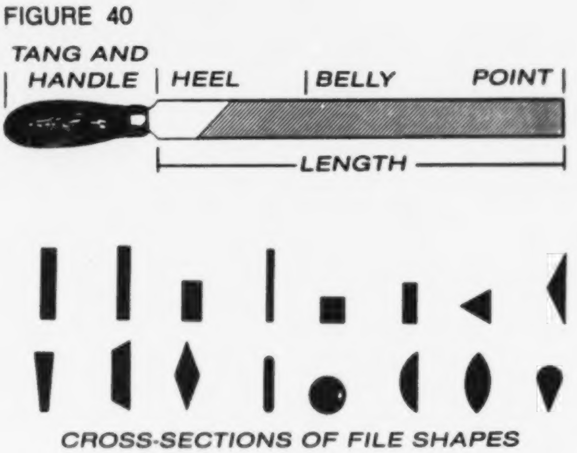
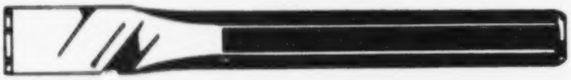


FIGURE 40
TANG AND HANDLE
HEEL
BELLY
POINT
LENGTH
CROSS-SECTIONS OF FILE SHAPES

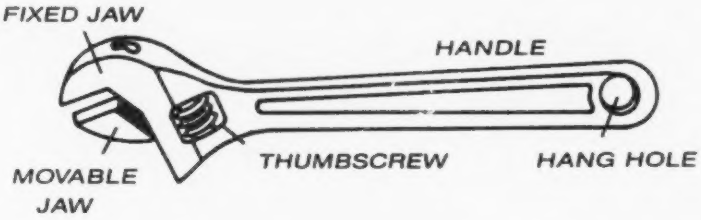
- Flat cold chisel — Used for cutting rivets, bolts, and metal; point is ground to 70° (Figure 42)

FIGURE 42



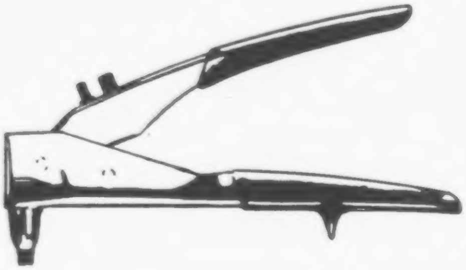
- Adjustable wrench — Designed to fit various size nuts within its capacity; comes in various sizes (Figure 43)

FIGURE 43


FIXED JAW
HANDLE
MOVABLE JAW
THUMBSCREW
HANG HOLE

- Pop-rivet gun — Rivet-setting tool designed for rivets to be inserted and set from one side in aluminum, steel, and copper; rivets range in size from ⅛ inch to ¼ inch (Figure 44)

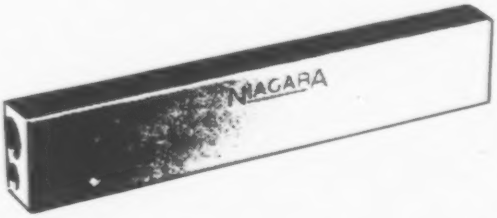
FIGURE 44



- Rivet set — Made with a deep hole used to pull tinner's rivets through metal, and a cup-shaped hole to set the rivets; a hole in the side is for releasing burrs. (Figure 45)

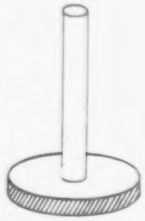
  NOTE: There are various size rivet sets for various size rivets, and the tool is also used for setting down a Pittsburgh lock.

FIGURE 45



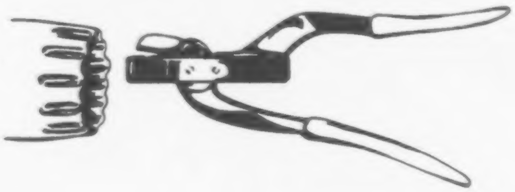
- Multiple-use dolly bar — Used to buck the head of a rivet as it is pulled together (Figure 46)

FIGURE 46



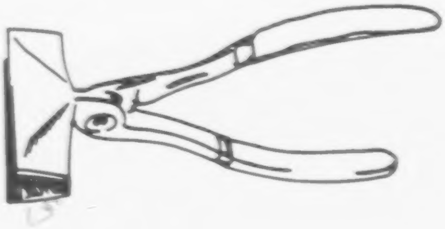
- Pipe crimper — Used to reduce the size of the end of a pipe; permits one end of a pipe to fit inside another piece that is the same size (Figure 47)

FIGURE 47



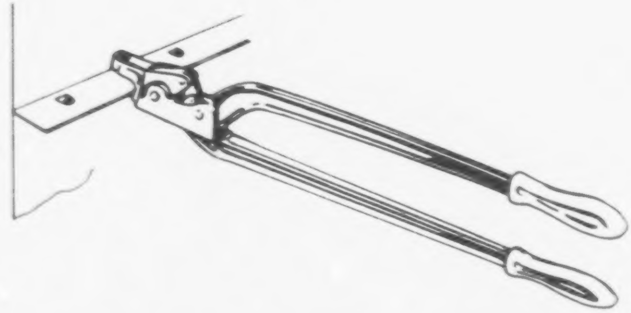
- Hand seamer — Makes bends on light gauge metal which is inconvenient to bend on a brake (Figure 48)

FIGURE 48



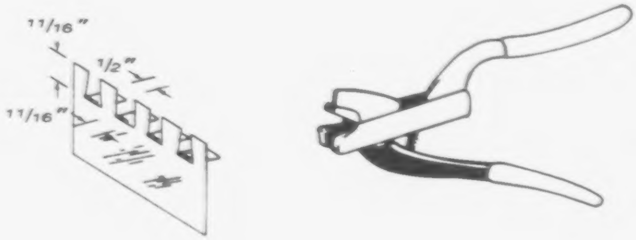
- Clip punch — An efficient tool for fastening seams in duct work; an "ear" is cut and bent out to be hammered tight with hammer (Figure 49)

FIGURE 49



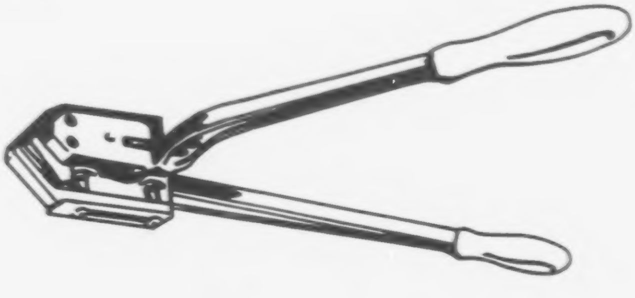
- Dovetailer — Used to cut clips for joining round pipe to a flat or round piece of metal (Figure 50)

FIGURE 50



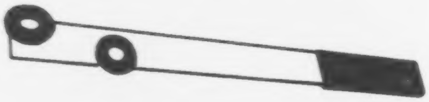
- Hand notcher — Used for notching ductwork corners for "S" and drive clips (Figure 51)

FIGURE 51



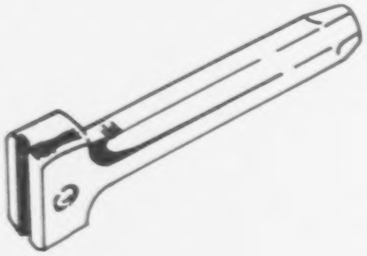
- Duct stretcher — Used to hook into drive cleats in ductwork to pull the duct together (Figure 52)

FIGURE 52



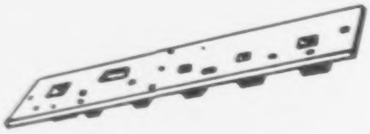
- Hand groover — Tool that is struck with a hammer to form hammer-lock pipe seams by hand; also used in completing Pittsburgh seams (Figure 53)

FIGURE 53



- Stake plate — Steel plate with various size holes designed to hold the tapered end of stakes firmly so the stakes can be used for forming metal (Figure 54)

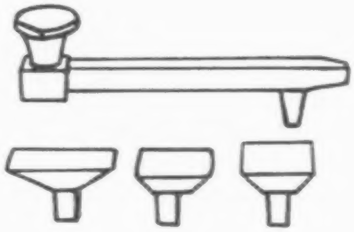
FIGURE 54



86

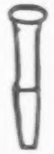
- Stakes — Shaping tools used with hand tools to complete numerous sheet metal operations such as tube forming, taper forming, flanging, side and circular seaming, box and pail seaming, riveting, and grooving (Figures 55-57)

FIGURE 55



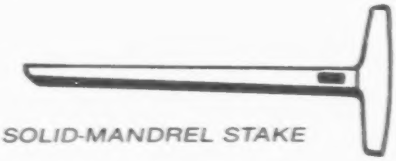
DOUBLE-SEAMING STAKE WITH FOUR HEADS

FIGURE 56



ROUND-HEAD STAKE

FIGURE 57

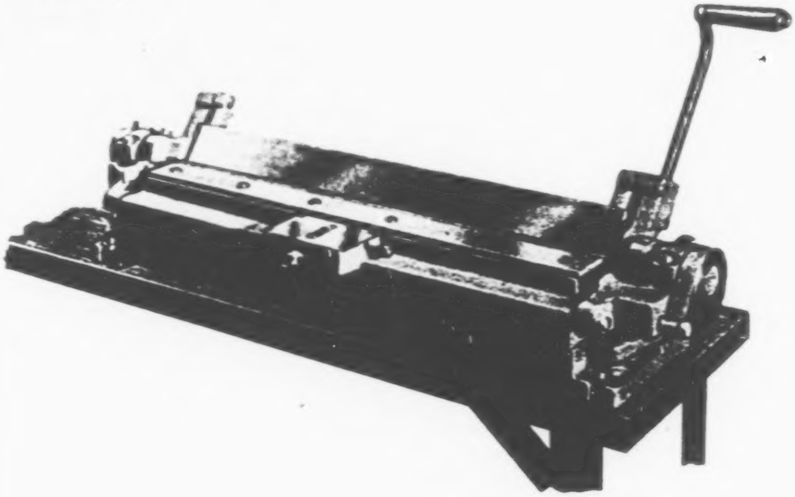


SOLID-MANDREL STAKE

OBJECTIVE 3 **Identify common sheet metal bench tools.**

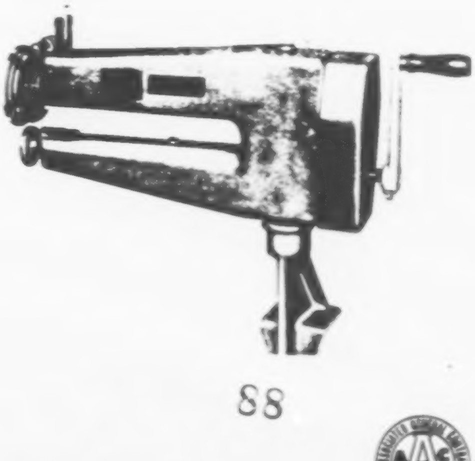
- Bench tools
  - — Adjustable-bar folder — For folding, bending, hemming, setting down, and making drive clips (Figure 58)

FIGURE 58



  - — Double seam machine — For double-seaming flat bottoms on straight or flared cylindrical articles (Figure 59)

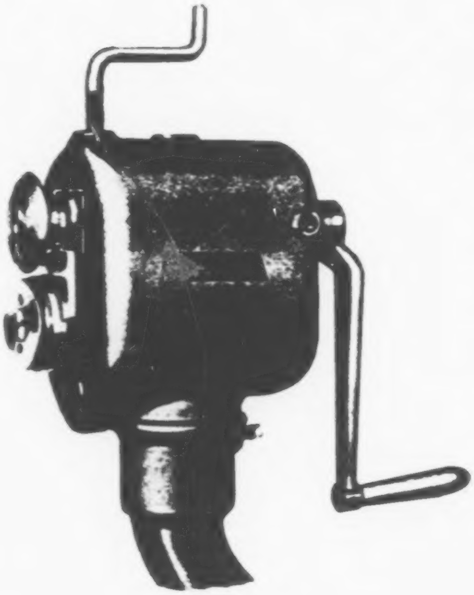
FIGURE 59



88

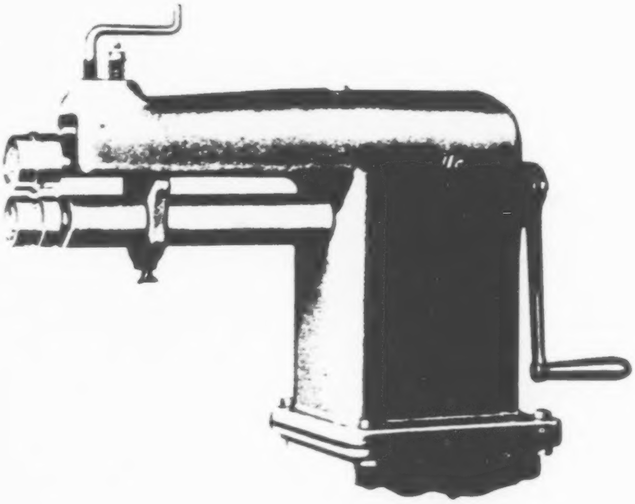
— Burring machine — For turning edges on circular discs such as bucket bottoms and for turning edges for double-seaming cylindrically shaped projects (Figure 60)

FIGURE 60



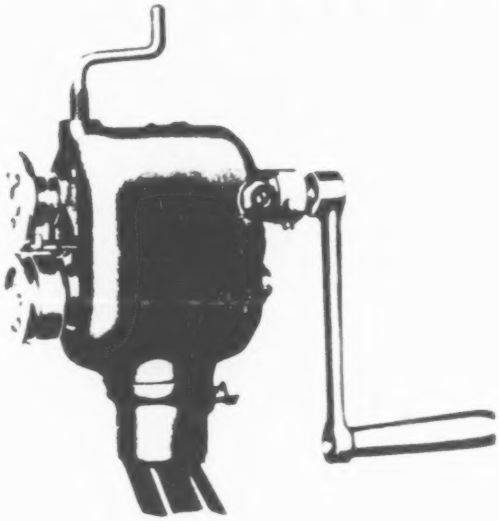
- Beading machine — For various beading operations with single and ogee rolls (Figure 61)

FIGURE 61



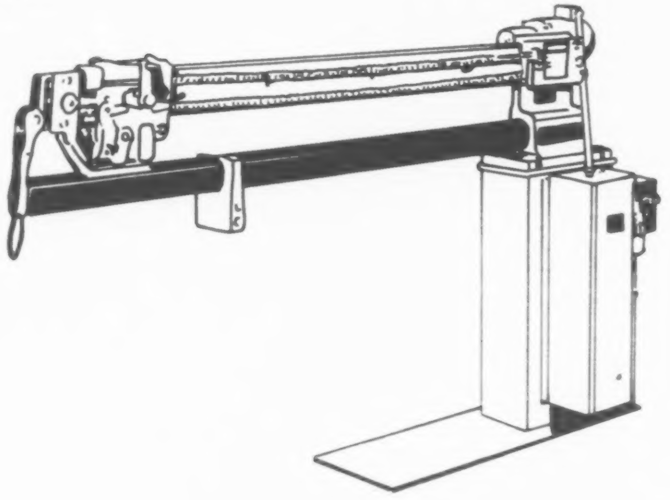
- Turning machine — For making rounded edges for wiring operations on cylinders and for double-seaming (Figure 62)

FIGURE 62



- Grooving machine — A specialized machine for grooving longitudinal seams in cylinders by grooving and flattening in one operation of the carriage (Figure 63)

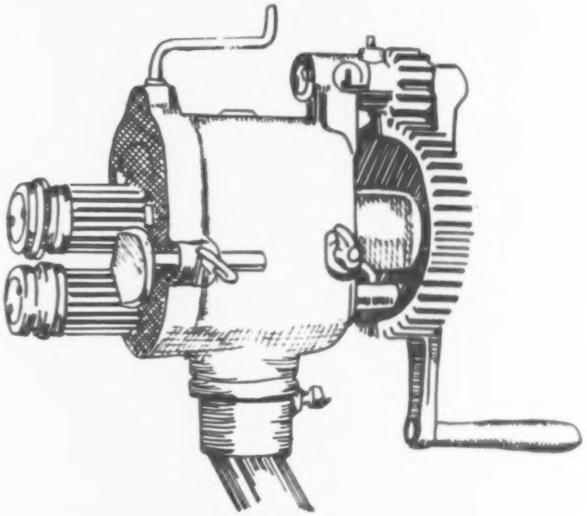
FIGURE 63



- Crimping and beading machine — For crimping and beading the end of a cylinder (Figure 64)

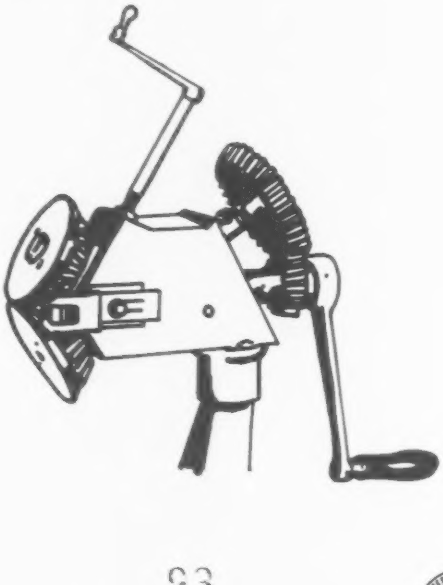
  NOTE: By changing the rolls, it will crimp or bead only.

FIGURE 64



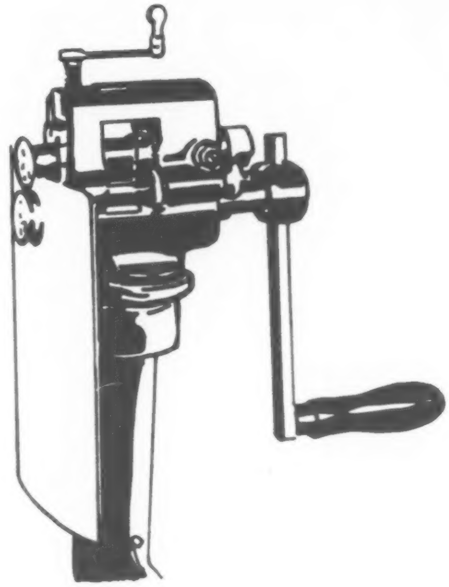
- Setting-down machine — For setting down seams on containers of various shapes (Figure 65)

FIGURE 65



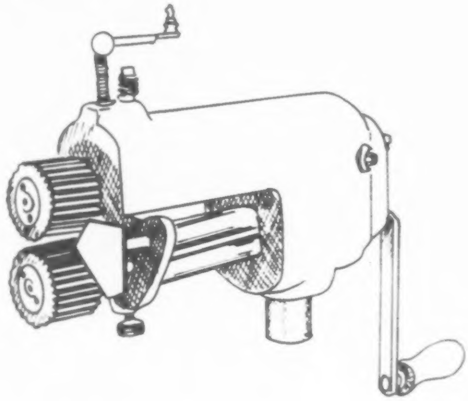
- Elbow-edging machine — For turning the edges of elbow gores so the gores can be assembled as a complete elbow with tight or adjustable joints (Figure 66)

FIGURE 66



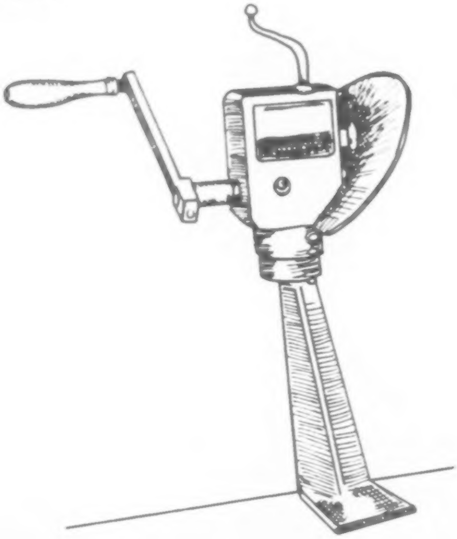
- Combination rotary machine — Has numerous interchangeable rolls to facilitate several different operations simply by changing to the desired set of rolls (Figure 67)

FIGURE 67



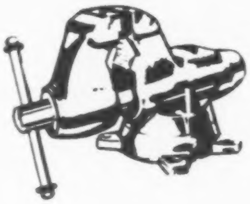
- Easy edger — Turns flanges on curved metal edges (Figure 68)

FIGURE 68



- Bench vise — For clamping stock to be worked on; the swivel base type is the most common type (Figure 69)

FIGURE 69

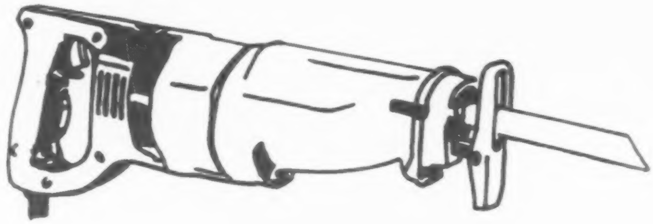


OBJECTIVE 4

Match drawings to the correct use of sheet metal power tools.

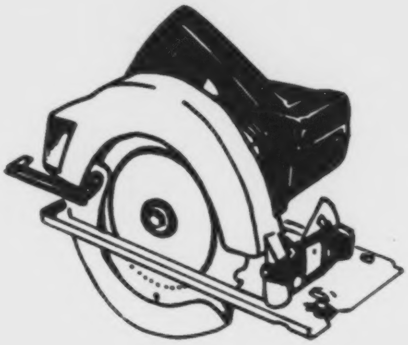
- Reciprocating saw — A portable electric keyhole saw with various types and sizes of blades for cutting wood, metal, plastics, and heavier steel (Figure 70)

FIGURE 70



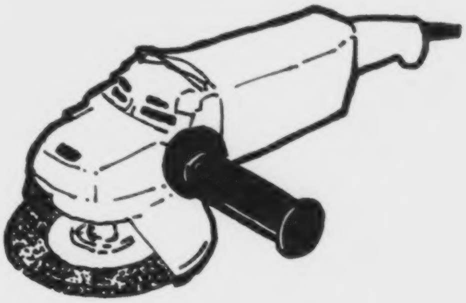
- Circular saw — A general purpose saw used in the construction trades for cutting wood, metal, and plastics (Figure 71)

FIGURE 71



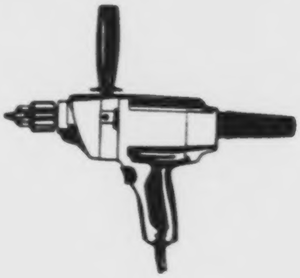
- Angle grinder — Generally used with attachments for cleaning joints after a welding process (Figure 72)

FIGURE 72



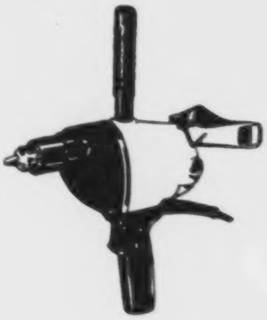
- Hand drill — Generally used for light drilling jobs; comes in various types such as variable-speed, reversible, ¼-inch, ⅜-inch, and ½-inch capacities (Figure 73)

FIGURE 73



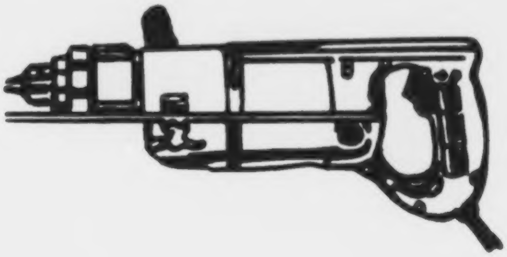
- Heavy-duty hand drill — Generally used for drilling heavy or thick materials; comes in various types such as variable-speed, reversible, ½-inch, ¾-inch, 1¼-inch capacities (Figure 74)

FIGURE 74



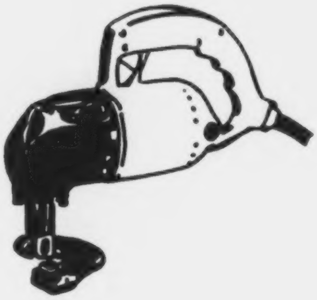
- Hammer drill — A heavy-duty drill with a percussion bit for drilling through masonry, brick, and tile (Figure 75)

FIGURE 75



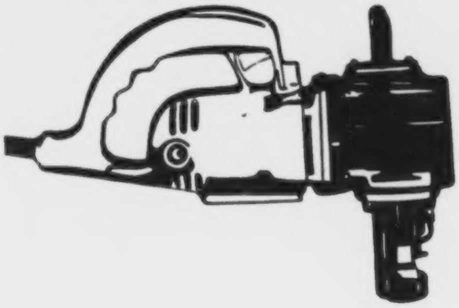
- Unishear — A hand-held metal-cutting shear for heavy metals (Figure 76)

FIGURE 76



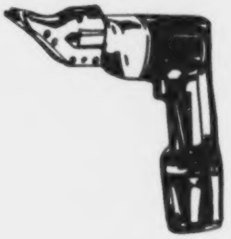
- Nibbler — Cuts metal by punching ⅛-inch pieces out of the metal with a rapid punching to speed up pattern cutting with light to heavy gauge metals (Figure 77)

FIGURE 77



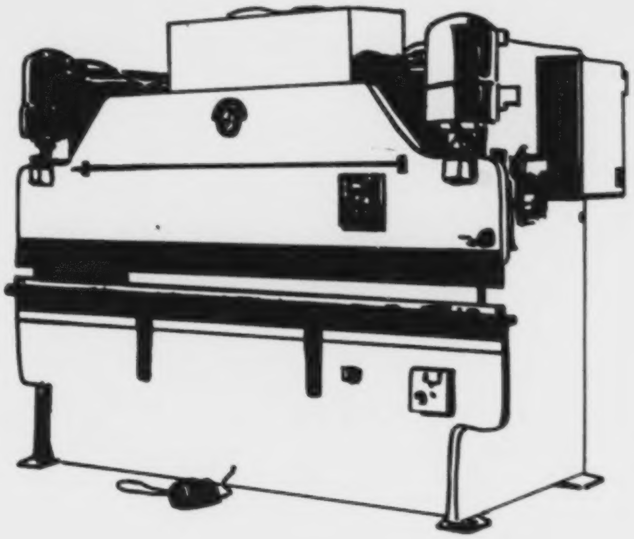
- Power double cuts — For cutting a cylinder into two or more pieces with minimum waste and time (Figure 78)

FIGURE 78



- Press brake — Has special dies that it presses metal into; it is more of a production tool and available in sizes from 4 feet to 35 feet long (Figure 79).

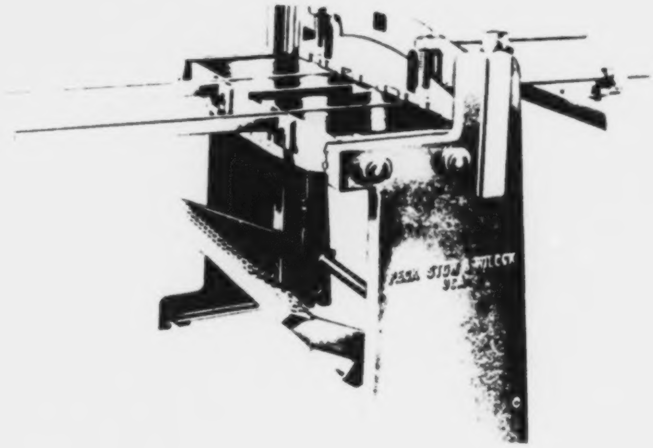
FIGURE 79



NOTE: In some sheet metal shops there are computerized numeric control (CNC) machines. Various types are available and may replace or supplement production tools such as the press brake, the shear, and the roller. When properly programmed, they can shear, roll, preform, and assemble sections of ductwork with little or no operator intervention.

- Square shear — Has a manually operated foot pedal for straight line cuts and is available in lengths from 3 feet to 10 feet (Figure 80)

FIGURE 80

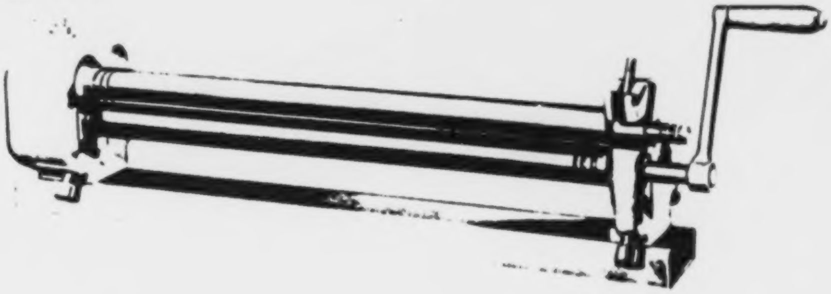


- Power shear — Similar to square shear except it is motor operated and run by hydraulic or mechanical arrangements (Figure 81)

FIGURE 81

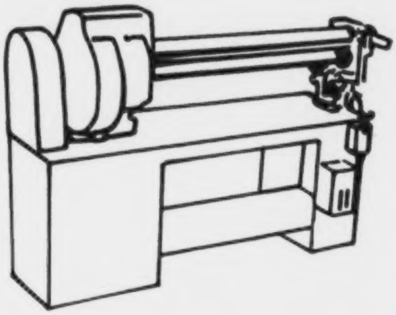
- Slip roll — Indispensable for making pipe and small round projects (Figure 82)

FIGURE 82



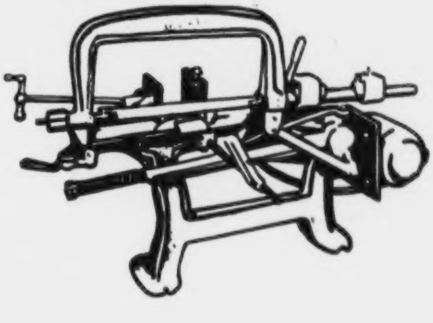
- Power roll — For production of cylindrical objects from heavier materials (Figure 83)

FIGURE 83



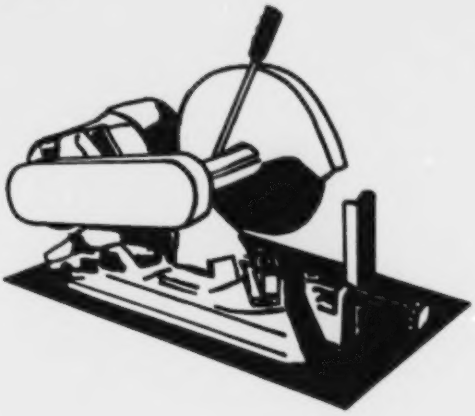
- Power hacksaw — Used to speed up production of cutting light steel pipe and angles (Figure 84)

FIGURE 84



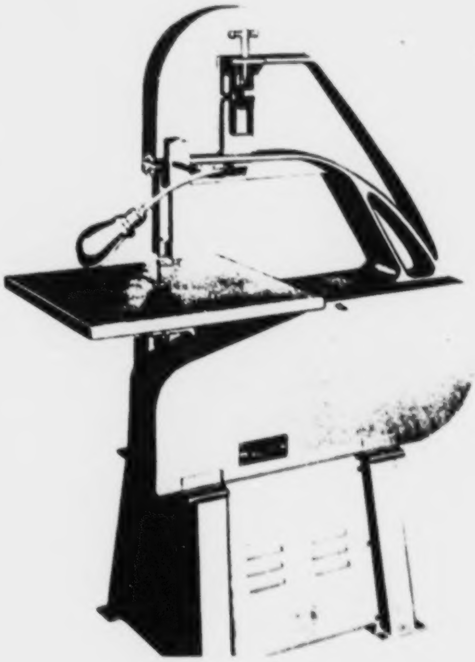
- Cut-off saw — Used to cut heavier steel at different angles or in straight cuts (Figure 85)

FIGURE 85



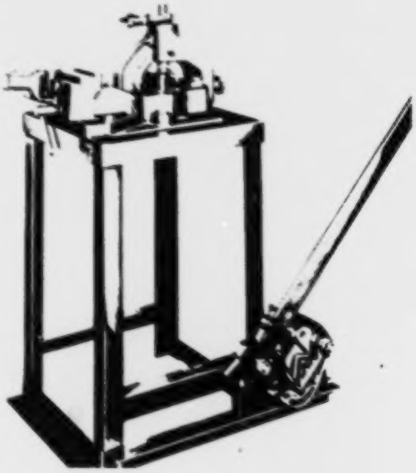
- Band saw — Has a continuous-cutting blade for cutting mild steel (Figure 86)

FIGURE 86



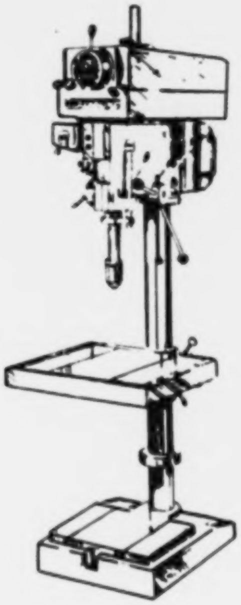
- Angle iron shear, notcher, and bender — Used to cut, notch, and bend angle iron, and is a must when angle iron is being worked with (Figure 87)

FIGURE 87



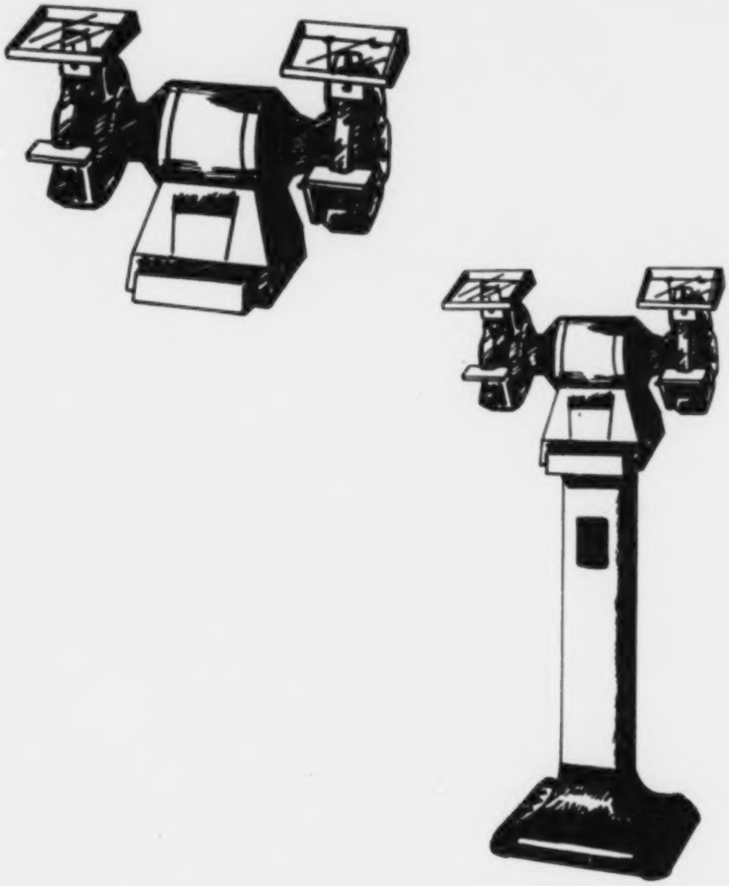
- Drill press — Used for drilling holes in several pieces of light metal at one time or drilling holes in single pieces of heavier metal (Figure 88)

FIGURE 88



- Bench or floor grinder — Used for grinding, sharpening, or cleaning up welded materials (Figure 89)

FIGURE 89



ASSIGNMENT SHEET 1

SHEET METAL TOOLS

A 2

Name ______________________________ Score __________

OBJECTIVE 5 **Given a list of sheet metal tools, match them to their correct use.**

INTRODUCTION There are many tools used in sheet metal construction. This exercise will allow you to practice your ability to match tools to their most common use.

INSTRUCTIONS Match types of measuring tools to their uses. Write the correct numbers in the blanks.

Functional Reading
- Follow written instructions

Functional Writing
- Complete forms and records

Part 1 — Measuring tools

_____a. Used for measuring linear distances; graduated to $\frac{1}{16}$ inch; usually 24 inches, 36 inches, or 48 inches long

_____b. Used to find the circumference of a circle when the diameter is known or the diameter of a circle when the circumference is known; also used as a straightedge and for other activities in layout work

_____c. Take up little space, are handy to carry and easy to use; available in lengths from 6 feet to 25 feet and graduated to $\frac{1}{16}$ inch

_____d. Commonly used in sheet metal work; usually 6 feet long and graduated to $\frac{1}{16}$ inch

1. Circumference rules
2. Retractable steel tape rules
3. Steel rules
4. Inside-reading folding rules

Part 2 — Dividers

______a. Used to construct large circles and arcs

______b. Used to construct small circles and arcs and to transfer dimensions

1. Trammel points
2. Wing dividers

Part 3 — Squares

______a. Used for accuracy in layout work; blades are available in 6-inch, 8-inch, 10-inch, and 12-inch lengths

______b. Used for layout accuracy with 45° and 90° angles

______c. Used in layout work for accuracy because all layout must start from a square corner

1. Framing squares
2. Try squares
3. Combination squares

Part 4 — Sheet Metal Snips

______a. Cuts to the left around curves and 90° corners

______b. Cuts to the right around curves and 90° corners

______c. Cuts straight lines or curves; one style has very short blades for special cutting needs

______d. Heavy duty snips used for all general cuts and thicker metals

______e. For cutting inside circles and metal close to an obstacle

1. Straight cut
2. Bulldog
3. Straight blade
4. Combination blade
5. Right cut
6. Circular
7. Left cut
8. Double cut

_____f. Best for cutting straight lines

_____g. Will cut curves by letting the metal slide over the top blade with ease and will also cut straight

_____h. Specifically designed to cut $\frac{1}{8}$-inch wide slit in preformed metal duct

Part 5 — Punches

_____a. Used to make small dents or establishing points for trammel points and wing dividers; point is ground to approximately 30°

_____b. Used for marking the location to be drilled; point is ground to approximately 90°

_____c. Used to punch small holes in light gauge metal; punches and dies range in size from $\frac{1}{16}$-inch to $\frac{9}{32}$-inch and are easily changed

_____d. Used on heavier gauge material; punches and dies range from $\frac{1}{16}$-inch to $\frac{1}{2}$-inch and are easily changed

1. Iron hand punch
2. Center punch
3. Tinner's hand punch
4. Prick punch

Part 6 — Hammers

_____a. Has a slightly curved, square face and beveled edges to prevent marking metal as rivets are set

_____b. Has a square, flat face and flat sides for closing up a Pittsburgh lock

1. Ball peen hammer
2. Mallet
3. Setting hammer

_____c. General purpose hammer with a curved face and round head

_____d. Not considered a sheet metal tool, but is found and used in almost all sheet metal shops

_____e. Used mostly as a finish tool, in cornice work,a nd in stainless steel work

_____f. Made of good hickory or rawhide and used where a metal hammer would dent or damage material

4. Body or raising hammer
5. Nail hammer
6. Riveting hammer

Part 7 — Pliers

_____a. Long nose and handle for deeper reach into work area

_____b. For holding an object that is difficult to hold with ones hands; should *not* be used as a wrench for removing nuts

_____c. Jaws are positioned and locked into place by engaging tongue in proper groove; a series of channels give wide range or jaw openings; jaws should not slip even under heavy pressure

_____d. Pliers adjust easily to lock at any size with desired amount of pressure; release lever opens jaws; can also be used as nonlocking pliers

1. Combination pliers
2. Adjustable pliers
3. Locking pliers
4. Long nose pliers

Part 8 — Metal Marking Devices

_____a. Used to scribe liens on metal in sheet metal layout; used with a guide

_____b. Used to scribe lines on metal using the edge of the metal as straightedge but can be used in many ways depending on type

1. Scratch gauge
2. Scratch awl

Part 9 — Gauges

_____a. Used for measuring uncoated sheet, plate iron and steel; based on weights in ounces per square foot

_____b. Used for measuring the thickness of sheets and wire made of nonferrous metals such as copper, brass, and aluminum

1. U.S. standard gauge
2. American standard wire gauge

Part 10 — Miscellaneous Tools

_____a. Makes bends on light gauge metal which is inconvenient to bend on a brake

_____b. Used to cut clips for joining round pipe to a flat or round piece of metal

_____c. Used for cutting rivets, bolts, and metal; point is ground to 70°

_____d. Used to hook into drive cleats in duct work to pull the duct together

1. Stake plate
2. Clip punch
3. Flat cold chisel
4. Rivet set
5. Hand groover
6. Hand seamer
7. Pipe crimper
8. Stakes

_____e. Used to buck the head of a rivet as it is pulled together

_____f. An efficient tool for fastening seams in duct work; an "ear" is cut and bent out to be hammered tight with a hammer

_____g. Used for notching ductwork corners for "S" and drive clips

_____h. Used to reduce the size of the end of a pipe; permits one end of pipe to fit inside another piece that is the same size

_____i. Steel plate with various size holes designed to hold the tapered end of stakes firmly so the stakes can be used for forming metal

_____j. Designed to fit various size nuts within its capacity; comes in various sizes

_____k. Tool that is struck with a hammer to form hammer-lock pipe seams by hand; also use din completing Pittsburgh seams

_____l. Used to cut various types of metal

_____m. Shaping tools used with hand tools to complete numerous sheet metal operations such as tube forming, taper forming, flanging, side and circular seaming, box and pail seaming, riveting, and grooving

9. Multiple-use dolly bar
10. File
11. Dovetailer
12. Adjustable wrench
13. Pop-rivet gun
14. Hand notcher
15. Duct stretcher
16. Hacksaw

_____n. Made with a deep hole used to pull tinner's rivets through metal and a cup shaped hole to set the rivets; a hole in the side is for releasing burrs

_____o. Rivet-setting tool designed for rivets to be inserted and set from one side in aluminum, steel, and copper; rivets range in size from ⅛- inch to ¼-inch

_____p. Used to remove burrs, to square the end of band iron,and to straighten uneven edges

Part 11 — Bench Tools

_____a. For folding, bending, hemming, setting down, and making drive clips

_____b. For double-seaming flat bottoms on straight or flared cylindrical articles

_____c. For turning edges on circular discs such as bucket bottoms and for turning edges for double-seaming cylindrically shaped projects

_____d. For various bending operations with single and ogee rolls

_____e. For making rounded edges for wiring operations on cylinders and for double-seaming

1. Burring machine
2. Grooving machine
3. Crimping and beading machine
4. Adjustable-bar folder
5. Beading machine
6. Double seam machine
7. Elbow-edging machine
8. Turning machine

_____f. A specialized machine for grooving longitudinal seams in cylinders by grooving and flattening in one operation of the carriage

_____g. For crimping and beading the end of a cylinder

_____h. For setting down seams on containers of various shapes

_____i. For turning the edges of elbow gores so the gores can be assembled as a complete elbow with tight or adjustable joints

_____k. Turns perfect flanges on curved metal edges

_____l. For clamping stock to be worked on; the swivel base type is the most common

9. Combination rotary machine
10. Easy edger
11. Bench vise
12. Setting-down machine

Part 12 — Power Tools

_____a. A portable electric keyhole saw with various types and sizes of blades for cutting wood, metal, plastics, and heavier steel

_____b. A general purpose saw used in the construction trades for cutting wood, metal, and plastics

_____c. Generally used with attachments for cleaning joints after a welding process

1. Angle grinder
2. Heavy-duty hand drill
3. Nibbler
4. Reciprocating saw
5. Circular saw
6. Hand drill

_____d. Generally used for light drilling jobs; comes in various types such as variable-speed, reversible, ¼-inch, ⅜-inch, and ½-inch capacities

_____e. Generally used for drilling heavy or thick materials; comes in various types such as variable-speed, reversible, ½-inch, ¾-inch, 1-inch, and 1¼-inch capacities

_____f. A hand-held metal-cutting shear for heavy metals

_____g. Separates metal by punching ⅛-inch pieces out of the metal with a rapid punching action to speed up pattern cutting with light to heavy gauge metals

_____h. For cutting a cylinder into two or more pieces with minimum waste and time

_____i. A heavy-duty drill with a percussion bit for drilling through masonry, brick, and tile

7. Power double cuts
8. Unishear
9. Hammer drill

ASSIGNMENT SHEET 2

SHEET METAL TOOLS

A 2

Name ______________________________ Score __________

OBJECTIVE 6

Provided with common sheet metal tools, identify them by their appearance.

INTRODUCTION

This exercise will allow you to practice the identification of commonly used sheet metal tools.

EQUIPMENT AND SUPPLIES

A selection of commonly used sheet metal tools

INSTRUCTIONS

Your instructor has tagged and numbered 12 hand tools that are frequently used in sheet metal work. Look the tools over carefully and write the name of each tool in the proper blank below.

#1 ____

#2 ____

#3 ____

#4 ____

#5 ____

#6 ____

#7 ____

#8 ____

#9 ____

#10 ____

Functional Reading
- Follow written instructions

Functional Writing
- Complete forms and records

Physical Science
- Analyze/classify matter

#11 ______________________________

#12 ______________________________

ASSIGNMENT SHEET 3

SHEET METAL TOOLS

A 2

Name ______________________________ Score __________

OBJECTIVE 7

Use a circumference rule to perform measurements.

INTRODUCTION

You will be using a segment of a circumference rule to determine the perimeter or outside boundary of a pipe after measuring its diameter.

EQUIPMENT AND SUPPLIES

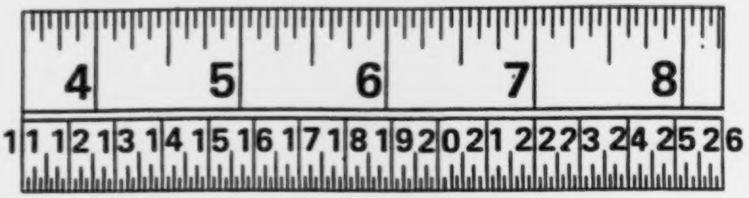
- Circumference rule

INSTRUCTIONS

The segment of a circumference rule shown below is to scale; use this plus full-length circumference rule to answer the following questions and perform the indicated activities.

Functional Reading
- Follow written instructions

Functional Writing
- Complete forms and records



A. What is the circumference of a pipe with a 7″ diameter?

____

B. What is the diameter of a pipe with a 19″ circumference? (Answer to the nearest 1⁄16″.)

____

votech

Math Application
- Solve word problems

Data Analysis and Display
- Interpret charts and tables

General Science
- Use scientific instruments

C. What is the total length to the nearest ¼" of the segment illustrated above?

____

D. What is the width to the nearest ¼" of the segment illustrated above?

____

E. Complete the following list of ways a circumference rule can be used.

1. As a straightedge for layout work
2. To make irregular curves in layout work
3. ______________________________
4. ______________________________
5. ______________________________

F. Turn to the appropriate table on the back of the circumference rule and determine the diameter and height required for a 20-gallon trash can.

Diameter: ______________, Height: ______________

NOTE: The tables on the back of the circumference rule are not frequently used, but every now and then they come in handy and it's good to know where to find quick references.

ASSIGNMENT ANSWERS

SHEET METAL TOOLS A 2

ASSIGNMENT SHEET 1

Part 1

a. 3
b. 1
c 2
d. 4

Part 2

a. 1
b. 2

Part 3

a. 2
b. 3
c. 1

Part 4

a. 7
b. 5
c. 1
d. 2
e. 6
f. 3
g. 4
h. 8

Part 5

a. 4
b. 2
c. 3
d. 1

Part 6

a. 6
b. 3
c. 1
d. 5
e. 4
f. 2

Part 7

a. 4
b. 1
c. 2
d. 3

Part 8

a. 2
b. 1

Part 9

a. 1
b. 2

Part 10

a. 6
b. 11
c. 3
d. 15
e. 9
f. 2
g. 14
h. 7
i. 1
j. 12
k. 5
l. 16
m. 8
n. 4
o. 13
p. 10

Part 11

a. 4
b. 6
c. 1
d. 5
e. 8
f. 2
g. 3
h. 12
i. 7
j. 9
k. 10
l. 11

Part 12

a. 4
b. 5
c. 1
d. 6
e. 2
f. 8
g. 3
h. 7
i. 9

ASSIGNMENT SHEET 2

Evaluated to the satisfaction of the instructor.

ASSIGNMENT SHEET 3

A. 22″
B. 6 1⁄16″
C. 4¾″
D. 1¼″

E. The following answers may be in any order.

   3. To find the circumference of a circle when only the diameter is known

   4. To find the diameter of a circle when only the circumference is known

   5. To measure length to 1/16"

F. Diameter: 17¼", Height: 19¾"

WRITTEN TEST

SHEET METAL TOOLS

A 2

Name ______________________________ Score __________

OBJECTIVE 1

Given a list of terms associated with sheet metal tools, match them to their correct definition. Write the letter that corresponds to the most correct answer.

_____ 1. One type of sheet metal seam is a/an

a. Pittsburg lock
b. interlock crease
c. overlap joint
d. western lock

_____ 2. Small tools that is powered by electricity or air and that can be comfortably moved from job to job are

a. hand tools
b. power-operated floor tools
c. portable power tools
d. portable tools

_____ 3. Machines for making cylindrical or rounded components are

a. brakes
b. rolls
c. gauges
d. block-outs

_____ 4. A tool for scratching on metal is a

a. gauge
b. scribe
c. rule
d. file

May be photocopied for student use.

_____ 5. A machine for forming sheet metal is a

a. bend gauge
b. steel rule
c. snip
d. brake

_____ 6. An irregular edge on sheet metal caused by improper use of cutting snips are called

a. roll spurs
b. cut splinters
c. burrs or fishhooks
d. cat-whiskers

_____ 7. To cut out the material required to complete a pattern is known as

a. blocking out
b. a stretchout
c. waste pattern
d. pattern snip

_____ 8. The unusable metal remaining after a pattern has been cut is called the

a. pattern
b. waste
c. outside border
d. secondary metal

_____ 9. The thickness of sheet metal and the diameter of wire are measured by their

a. pound-per-square-inch
b. cylindrical volume
c. seam roll
d. gauge

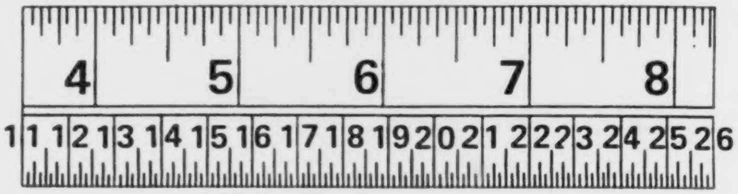
May be photocopied for student use.

_____10. Small, hand operated tools generally anchored to a bench are known as

a. power tools
b. portable tools
c. bench tools
d. hand tools

OBJECTIVE 2 **Given drawings, match sheet metal tools to their use.**

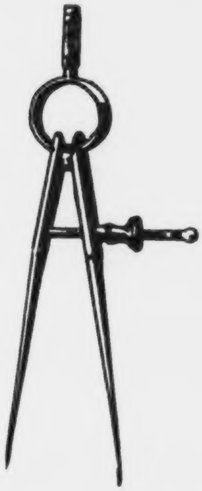
_____ 1. The drawing below represents a



a. steel rule used to find the circumference of a circle
b. circumference rule that can be used as a straight-edge
c. valley rule to measure the distance of depressions in sheet metal
d. incremental running rule

May be photocopied for student use.

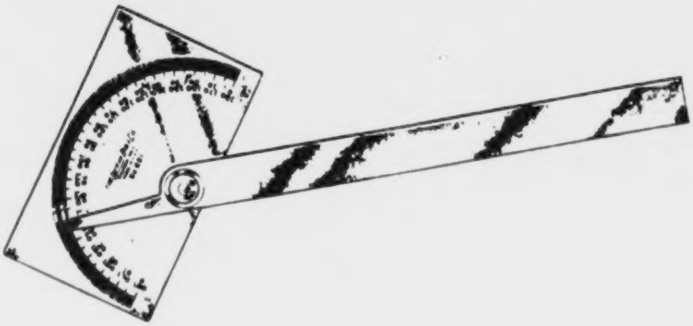
_____ 2. The tool below is



a. a trammel point and is used to construct large circles
b. wing divider to mark squares on sheet metal
c. blade protractor to draw angle on sheet metal
d. wing divider to construct small circles and arcs

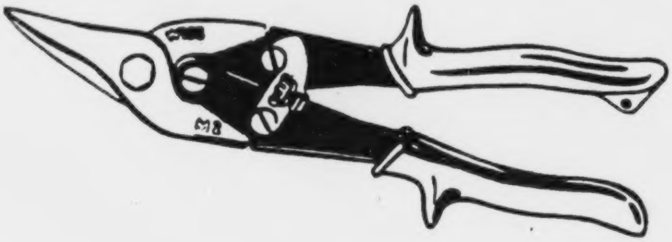
May be photocopied for student use.

_____ 3. The tool shown below is a



a. steel swinging-blade protractor to find angles of different degrees
b. bevel protractor to find angles of different degrees
c. sheet metal square to mark angles
d. cut scribe used to mark sheet metal

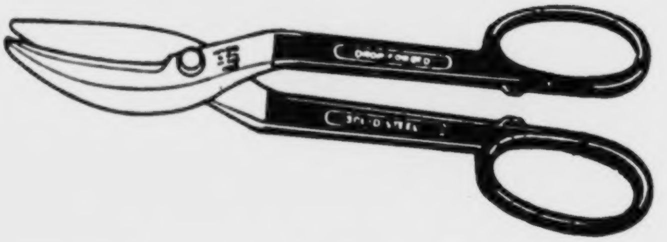
_____ 4. This tool is used to



a. snip sheet metal when curves are to the left
b. snip sheet metal when curves are to the right
c. cut stainless steel
d. snip sheet metal of .028 gauge and below

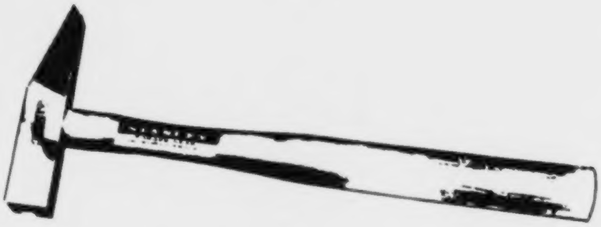
May be photocopied for student use.

_____ 5. The tool shown below is



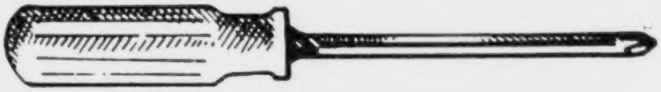
a. a circular snip to cut inside circles
b. a bulldog snip to cut straight lines
c. a circular snip to cut thicker metals
d. a double cut snip

_____ 6. The hammer shown below is used to



a. drive and pull nails
b. remove dents in sheet metal
c. close a Pittsburg seam
d. finish cornices

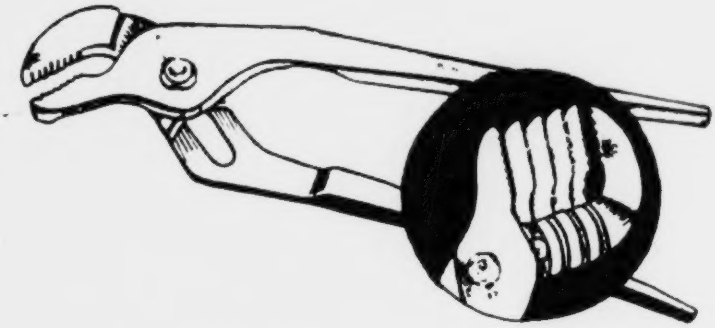
_____ 7. This screw driver is



a. a standard head used on bolts and screws
b. torx head used to adjust power tools
c. Phillips head used on bolts and screws
d. Phillips head used on slotted bolts and screws

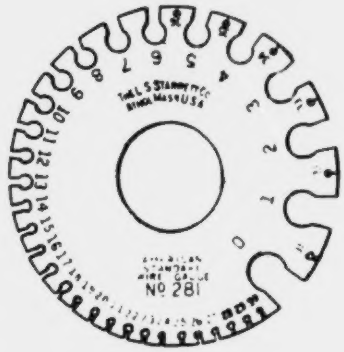
May be photocopied for student use.

_____ 8. These adjustable pliers are also known as



a. channel locks
b. combination pliers
c. locking pliers
d. vise grips

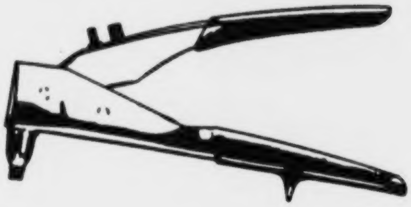
_____ 9. What is the name and use of the tool shown below?


THE L.S. STARRETT CO
ATHOL MASS USA
AMERICAN
STANDARD
WIRE GAUGE
Nº 281

a. U.S. standard gauge for measuring wire diameter
b. American standard gauge for measuring metal thickness and wire diameter
c. English standard for measuring wire diameter
d. American standard gauge for measuring metal width and length

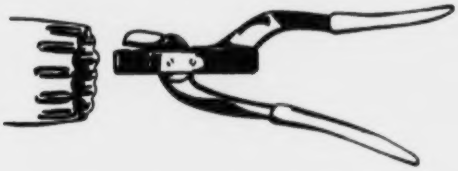
May be photocopied for student use.

_____10. This tool is a



a. sheet metal stapler
b. circular scribe
c. pipe crimper
d. pop-rivet gun

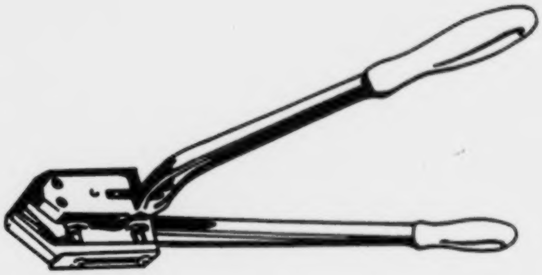
_____11. The tool shown below is a



a. crimp remover
b. pipe rivet gun
c. saddle former
d. pipe crimper

May be photocopied for student use.

_____12. The tool shown below is a

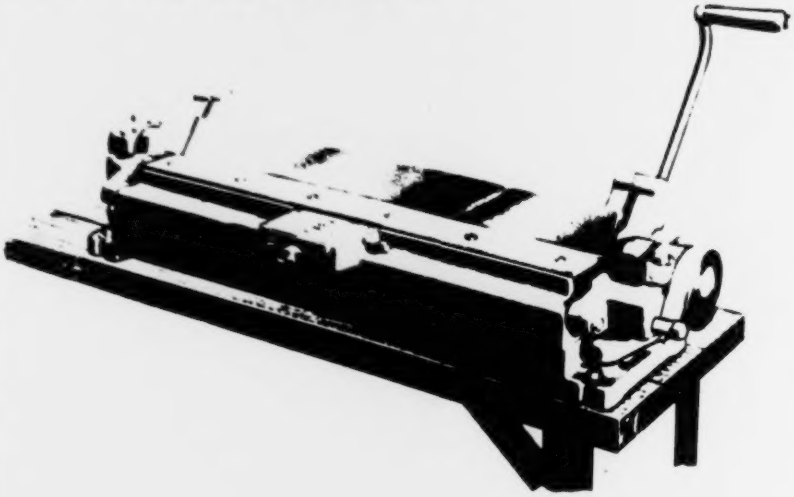


a. dovetailer
b. duct stretcher
c. hand notcher
d. hand groover

May be photocopied for student use.

OBJECTIVE 3 **Identify common sheet metal bench tools.**

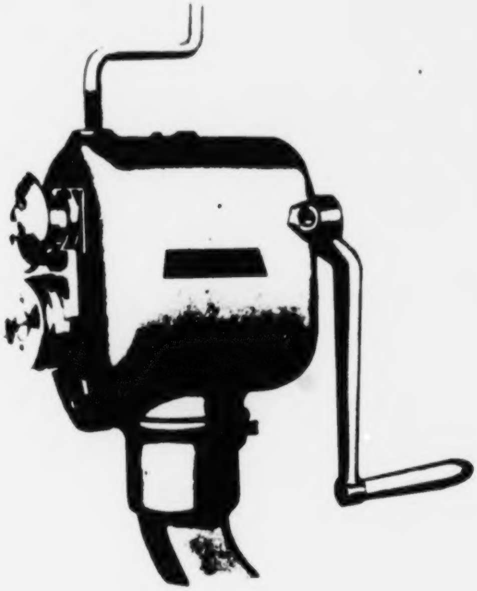
_____ 1. The bench tool shown below is a



a. double seam machine
b. adjustable-bar folder
c. burring machine
d. beading machine

May be photocopied for student use.

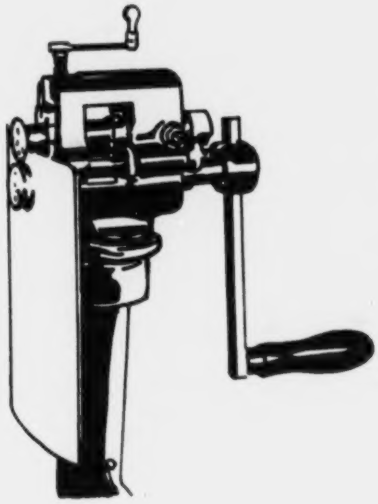
_____ 2. The figure below represents a



a. burring machine
b. grooving machine
c. setting-down machine
d. combination vise

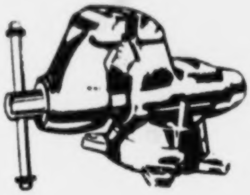
May be photocopied for student use.

_____ 3. The bench tool shown below is a



a. rotary vise
b. knee-edge machine
c. elbow-edging machine
d. seam creaser

_____ 4. This bench tools is a

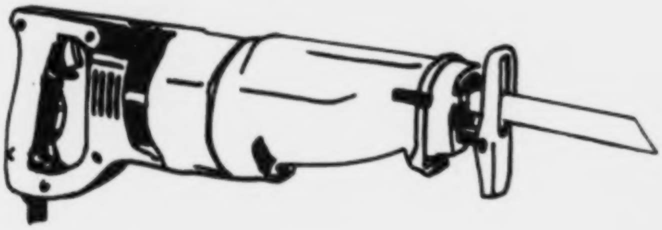


a. vise
b. clamp
c. seam bender
d. table jointer

May be photocopied for student use.

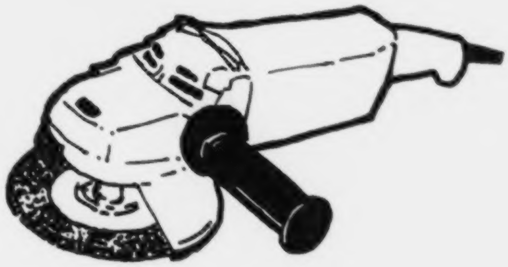
OBJECTIVE 4 **Match drawings to the correct use of sheet metal power tools.**

_____ 1. This power tool is a



a. circular saw to cut wood, metal, and plastic
b. angle grinder
c. reciprocating saw to cut various materials
d. reciprocating drill

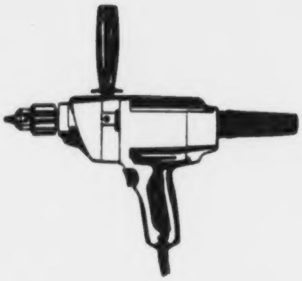
_____ 2. This tool is used to



a. clean joints after a welding process
b. cut sheet metal
c. drill holes in concrete
d. punch small holes in light gauge sheet metal

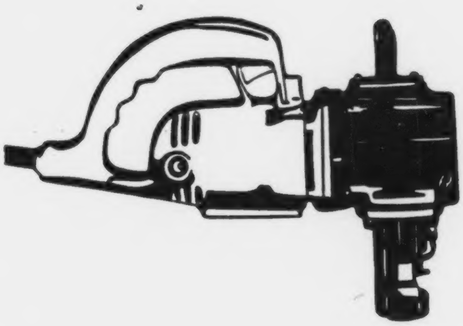
May be photocopied for student use.

_____ 3. The tool shown below is most often used for



a. drilling holes in 4″ stainless steel
b. cleaning welded joints
c. shearing light steel
d. light drilling jobs

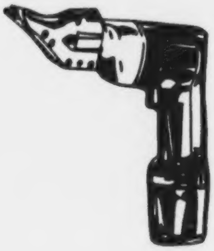
_____ 4. The tool below is a



a. double cutter
b. nibbler to cut metals
c. punch to set rivets
d. power drill

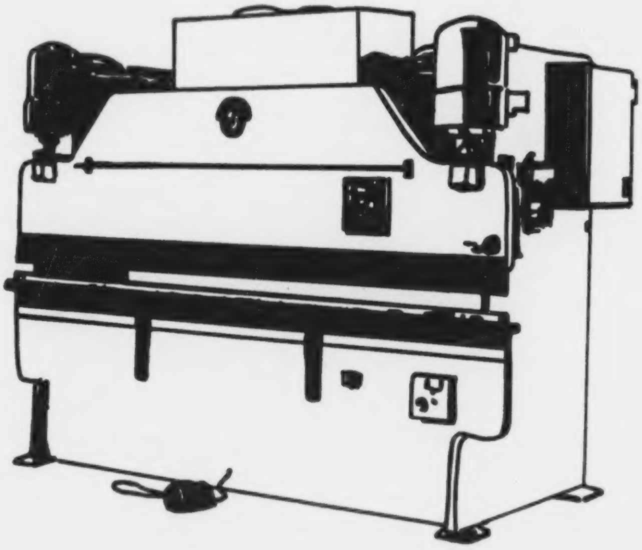
May be photocopied for student use.

_____ 5. This power tool is a



a. nibbler to cut metal
b. power shear
c. power double cut
d. unishear

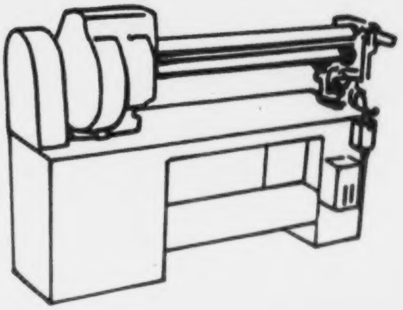
_____ 6. This tool is called a



a. power shear to cut metal
b. square shear
c. slip roll
d. press brake to form metal

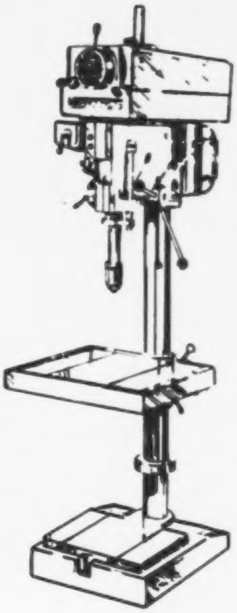
May be photocopied for student use.

_____ 7. This tool is a



a. power roll to form sheet metal
b. utility saw
c. circular saw
d. power hacksaw to cut light steel pipe

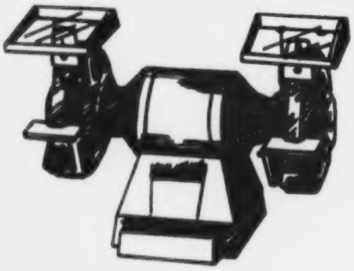
_____ 8. This power tool is a



a. drill press to drill holes in wood or metal
b. drill press to cut light gauge sheet metal
c. bench press
d. power shear to cut heavier material

May be photocopied for student use.

_____ 9. The power tool is used to



a. grind
b. sharpen
c. clean welds
d. all the above

NOTE: Objectives 5-7 are evaluated on assignment sheets in this unit. If you have not completed these components, see your instructor.

May be photocopied for student use.

WRITTEN TEST ANSWERS

SHEET METAL TOOLS

A 2

OBJECTIVE 1

1. a
2. c
3. b
4. b
5. d
6. c
7. a
8. b
9. d
10. c

OBJECTIVE 2

1. b
2. d
3. a
4. b
5. a
6. c
7. c
8. a
9. b
10. d
11. d
12. c

OBJECTIVE 3

1. b
2. a
3. c
4. a

OBJECTIVE 4

1. c
2. a
3. d
4. b
5. c
6. d
7. d
8. a
9. d

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) INTRODUCTION TO SHEET METAL

UNIT NUMBER AND TITLE – A2 – SHEET METAL TOOLS

TOTAL NUMBER OF TEST QUESTIONS 35

TOTAL NUMBER OF BASIC SKILL QUESTIONS 1

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	1-8, 10	X
1	9	M
2	1-12	X
3	1-5	X
4	1-9	X

OBJECTIVE SHEET

APPLIED SKILLS

A 3

INTRODUCTION

This unit defines terms in preparing to lay out and form sheet metal. The terms are supplemented by allowing you to apply the basic skills and use tools to form sheet metal to written job specifications.

PREREQUISITE

Fundamentals of Construction

UNIT OBJECTIVE

After completing this unit, the student should be able to form sheet metal to specification. The student will demonstrate these competencies by completing the assignment sheets, job sheets, and written test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to show the ability to:

1. Given a list of terms associated with sheet metal skills, match them to their correct definition.
2. Match geometric figures to their correct titles.
3. Perform basic sheet metal layout procedures. (Assignment Sheet 1)
4. Identify basic methods for interlocking or joining sheet metal. (Assignment Sheet 2)
5. Given drawings, recognize basic types of sheet metal fittings.
6. Lay out and cut sheet metal to a rectangle. (Job Sheet 1)
7. Lay out and cut a circle in sheet metal. (Job Sheet 2)
8. Lay out and form a metal box. (Job Sheet 3)
9. Lay out and form a rectangular duct. (Job Sheet 4)

SUGGESTED ACTIVITIES

APPLIED SKILLS

A 3

PREPARATION

- Review unit and plan presentation.
- Order or obtain materials to supplement unit.
- Give an overview of the course, explaining the organization of the materials from the foundation to the finished house.
- Introduce unit.

DELIVERY

Objective 1: Given a list of terms associated with sheet metal skills, match them to their correct definition.

- Discuss any sheet metal terms that are unique to your geographic area.
- Show examples of each term, if possible.
- Ask an experienced sheet metal worker to address the class.
- Use TM 1 to discuss clips and hems.

Objective 2: Match geometric figures to their correct titles.

- Explain that understanding these terms is essential to being able to lay out sheet metal projects.

APPLICATION

Objective 3: Perform basic sheet metal layout procedures. (Assignment Sheet 1)

Objective 4: Identify basic methods for interlocking or joining sheet metal. (Assignment Sheet 2)

Objective 5: Given drawings, recognize basic types of sheet metal fittings.

Objective 6: Lay out and cut sheet metal to a rectangle. (Job Sheet 1)

Objective 7: Lay out and cut a circle in sheet metal. (Job Sheet 2)

Objective 8: Lay out and form a metal box. (Job Sheet 3)

Objective 9: Lay out and form a rectangular duct. (Job Sheet 4)

- Assign Assignment Sheets 1 and 2.
- Allow students to practice the procedures in the job sheets.

EVALUATION

Pretest

- Give written test as pretest.
- Determine individual study requirements from pretest results.
- Counsel students individually on pretest results and study requirements.
- Modify materials in unit or create supplementary materials for individual students as required.

Skill Test

- Evaluate students on assignment sheet activities.
- Evaluate students on job sheet activities.
- Complete appropriate section of competency profiles.
- Reteach and reevaluate if necessary.
- Modify materials in unit or create supplementary materials for individual students as required.

Written Test

- Explain to students that they will be asked to demonstrate on the written test actions listed in the specific objectives.

- Give the written test.

  NOTE: The written test may be given in sections if desired.

- Complete appropriate sections of competency profiles.
- Reteach and retest if necessary.
- Review individual and group performance in order to evaluate teaching methods. Adjust scope, sequence, or instructional approaches for additional lessons as required.

UNIT REFERENCES

- Jones, Leonard and Morse, Otto. *Sheet Metal Basics.* Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, Inc., 1983.
- Toenjes, Leonard P. *Building Trades Dictionary.* American Technical Publishers, Inc.: Homewood, IL.

OBJECTIVE 1

Given a list of terms associated with sheet metal skills, match them to their correct definition.

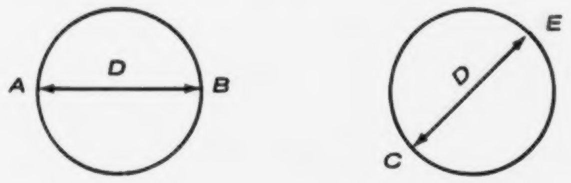
- **arc** — a segment of a circle
- **area** — measure of a flat surface; expressed in square units

  EXAMPLE: A 3′-0″ × 4′-0″ piece of sheet metal has an area of 12 square feet.

- **bisect** — divide into two equal parts
- **block out** — a term used to describe the cutting out of material required to complete a pattern
- **chord** — a straight line joining any two points on an arc, curve, or circumference
- **circumference** — distance around outer edge of a circle
- **clip** — piece or pieces of metal formed specifically for holding two or more sections of duct together
- **diameter** — distance between outer edges of a circle through center point

  EXAMPLE: AB and CE represent the diameter; see Figure 1

FIGURE 1



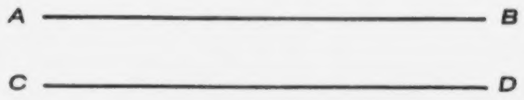
- **edge** — procedure or method of stiffening or adding strength to the edge of a piece of metal by reforming the metal or adding preformed metal to eliminate raw edges
- **ellipse** — the path of a point that moves so that the sum of its distance from two fixed points is constant to create a figure that falls short of a perfect circle
- **equilateral** — a figure having all sides equal
- **geometric figure** — shape formed by straight or curved lines
- **hem** — sheet metal edge formed to add strength (see edge)
- **joint** — any point where two pieces of round or rectangular duct join together or where fittings join duct
- **lineal** — relating to, consisting of, or resembling a straight line
- **lock** — similar to seam; usually refers to applications

  NOTE: The definitions of *seam, lock,* and *joint* may vary in different parts of the country.

- **notch** — angle cut in the edge of a piece of metal to facilitate the forming of seams, hems, and joint allowances (example: dovetail notch)
- **parallel** — extending in the same direction an equal distance apart and never meeting

  EXAMPLE: Lines AB and CD are parallel to each other; see Figure 2

FIGURE 2

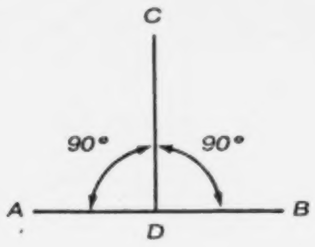


- **perimeter** — outer limits or boundary

- **perpendicular** — line or surface at a right angle to another line or surface

  EXAMPLE: Line CD is perpendicular to line AB; see Figure 3

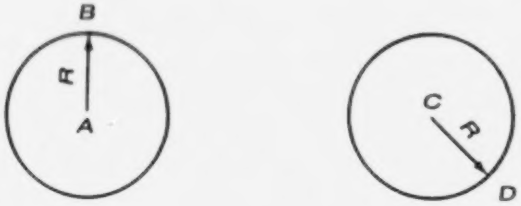
FIGURE 3



- **pi** — Greek letter (Π) representing the ratio of a circle's circumference to its diameter, which is approximately 3.1416
- **point of tangent** — the point at which a line or a plane touches a curve, an arc, or a circumference
- **radius** — distance from center of a circle to any point on edge of circle

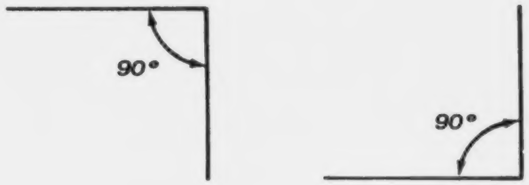
  EXAMPLE: AB and CD represent the radius; see Figure 4

FIGURE 4



- **right angle** — angle formed by two lines perpendicular to each other; 90-degree angle (Figure 5)

FIGURE 5



- **seam** — procedure or method by which two pieces of metal are joined together

- **tab** — material intended to be bent for an anchoring point or a lap allowance

- **tangent** — a line or plane that touches at only one point but does not intersect a curve, an arc, or a circumference

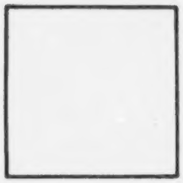
- **tap in** — lock formed by placing one piece of duct inside another and securing it from inside with dovetailed tabs

OBJECTIVE 2 **Match geometric figures to their correct titles.**

- Geometric figures

  — Square — Figure having four sides of equal length and four right angles (Figure 6)

FIGURE 6

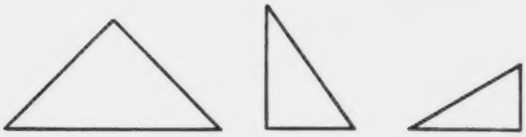


- Rectangle — Figure with two parallel ends of equal length, two parallel sides of equal length, and four right angels (Figure 7)

FIGURE 7

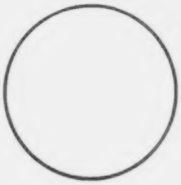
- Triangle — Figure having three sides and three angles (Figure 8)

FIGURE 8



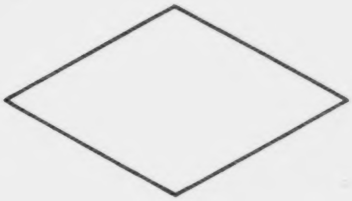
- Circle — Flat, round figure formed by one curved line; all points of curved line are equidistant from center point (Figure 9)

FIGURE 9



- Rhombus — Figure having no right angles and four sides of equal length (Figure 10)

FIGURE 10



- Parallelogram — Figure such as a square, rectangle, or rhombus with two parallel ends of equal length and two parallel sides of equal length (Figure 11)

FIGURE 11

- Trapezoid — Figure with only one pair of parallel opposite sides (Figure 12)

FIGURE 12

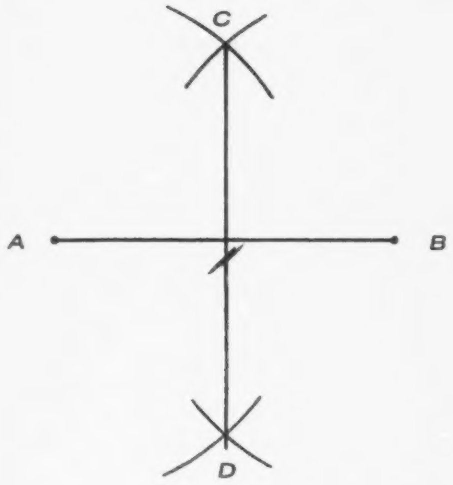
OBJECTIVE 3 **Perform basic sheet metal layout procedures.** (Assignment Sheet 1)

NOTE: Review the following procedures in preparing to mark and cut sheet metal.

- Bisecting a straight line (Figure 13)

  1. Draw line AB.
  2. With A and B as center, and a radius greater than one half of line AB, swing arcs above and below line AB creating points C and D.
  3. Connect points C and D with a straight line.

FIGURE 13



- Bisecting an angle (Figure 14)

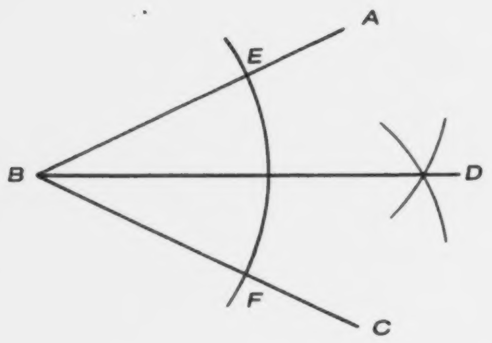
  1. Construct triangle ABC.

2. With B as center and a convenient radius, swing arc E through F.

3. With E and F as centers and the radius greater than one-half of the distance EF, swing arcs intersecting at D.

4. Draw line BD.

FIGURE 14



- Erecting a perpendicular line at the end of a straight horizontal line (Figure 15)

    1. Draw line AB.

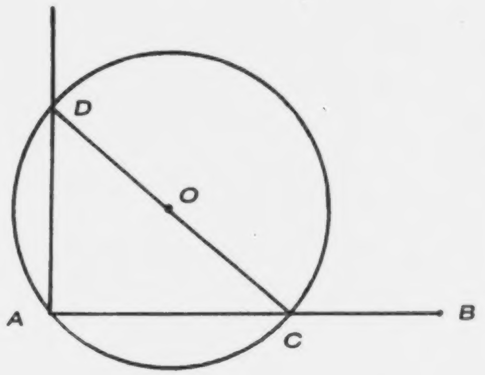
    2. Select the point O outside and at a convenient distance above the line.

    3. With O as center and OA as a radius, draw a circle creating point C.

    4. Draw line from point C through point O creating point D.

5. Draw line A through D

FIGURE 15



- Laying out a perpendicular line from a given point on a line (Figure 16)

    1. Draw line AB.

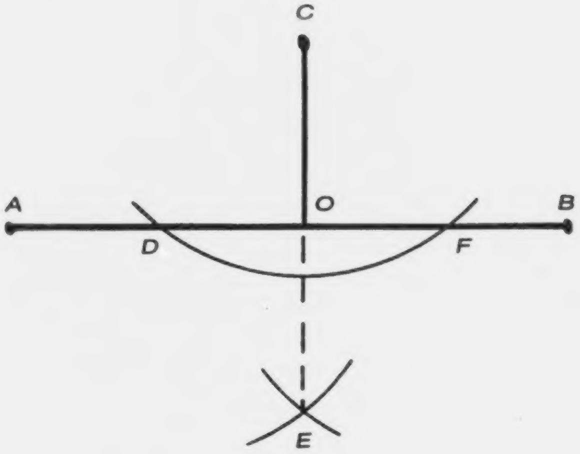
    2. Place point C above line.

    3. With C as the center, swing an arc creating points D and F.

    4. With D and F as centers, create point E.

5. Draw line C to E.

FIGURE 16



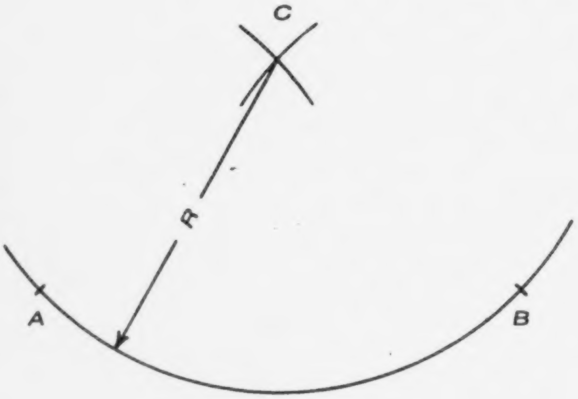
- Marking an arc of a given radius through two given points (Figure 17)

1. Create points A and B.

2. With R as the radius, and points A and B as the centers, create point C.

3. With point C as the center and R as the radius, swing arc AB.

FIGURE 17

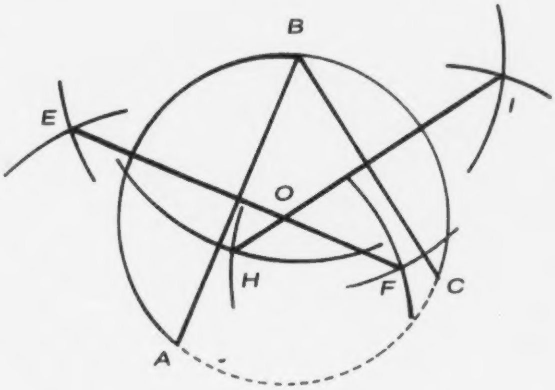


- Passing an arc through three given points (Figure 18)

  1. Create points ABC.
  2. Connect points ABC.
  3. Bisect line AB.
  4. Bisect line BC, creating point O.

5. With point O as center and OA as the radius, swing arc ABC.

FIGURE 18



- Dividing a line into equal length parts (Figure 19)

1. Draw line AB.

2. Draw line AC at convenient degree and distance.

3. With AD as radius, step off desired number of segments, indicated by D, E, F, G, and H.

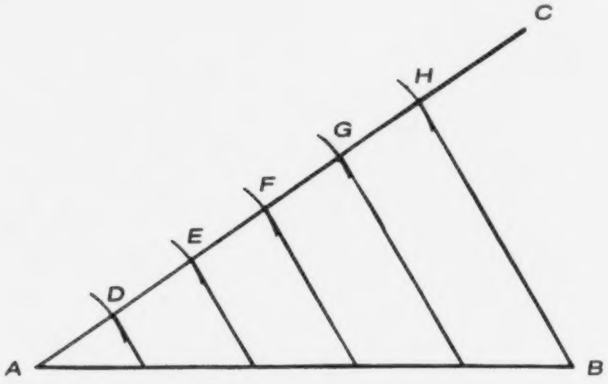
   NOTE: In this case the line will be divided into five equal parts.

4. Draw line HB.

   NOTE: If four equal parts were desired, a line GB would be drawn, and so forth.

5. Draw lines parallel to HB through points G, F, E, and D; this divides line AB into equal parts.

FIGURE 19



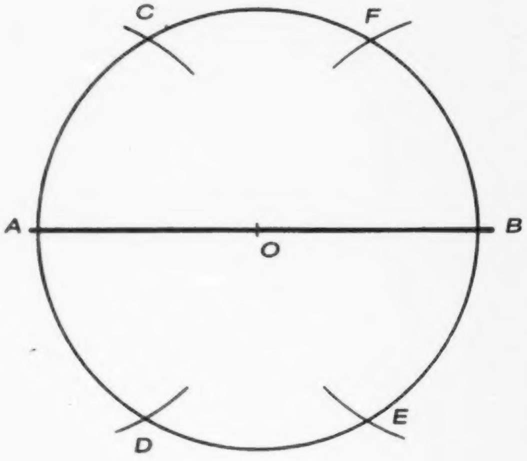
- Dividing a circle into six equal parts (Figure 20)

  1. Construct a circle with AB as the diameter and O as the center.

  2. With A as a center and AO as the radius, create points C and D.

3. With B as the center and AO as the radius, create points E and F; this divides a circle into six equal parts.

FIGURE 20



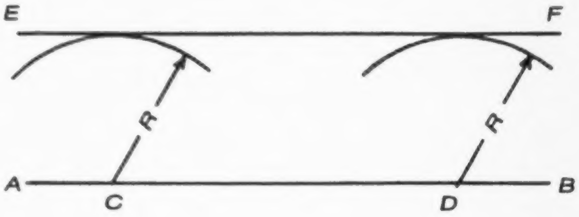
- Constructing parallel lines (Figure 21)

1. Draw line AB.

2. With R as the radius, swing arcs from any two points on line AB.

3. Draw line EF tangent to arcs to complete parallel line.

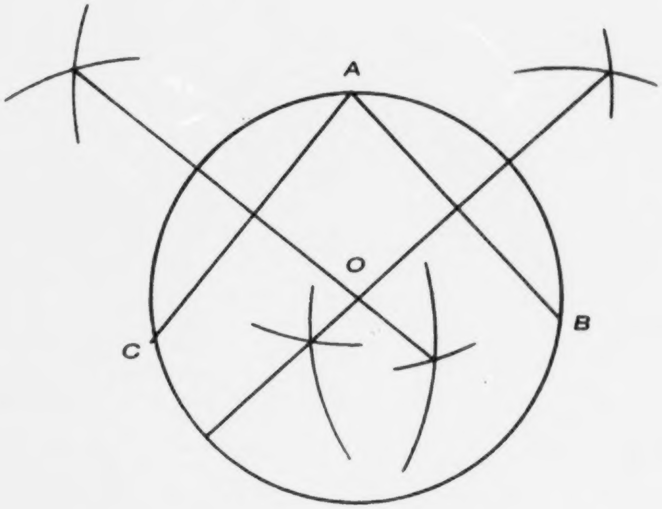
FIGURE 21



- Finding the center of a circle (Figure 22)

    1. Circle is given and drawn.
    2. Draw chord AB.
    3. Bisect chord AB.
    4. Draw chord AC.
    5. Bisect chord AC.
    6. The intersection of the bisectors, O, is the center of the circle.

FIGURE 22

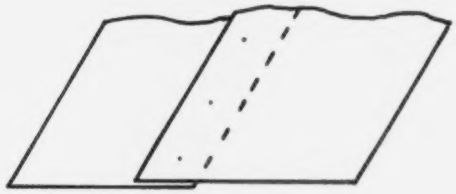


OBJECTIVE 4

Identify basic methods for interlocking or joining sheet metal. (Assignment Sheet 2)

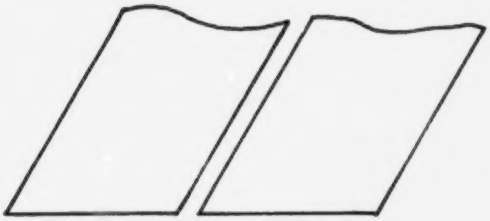
- Basic types of sheet metal seams
  - Lap seam — Seam most commonly used on small projects such as short, round cylinders; can be spot welded, riveted, or soldered (Figure 23)

FIGURE 23



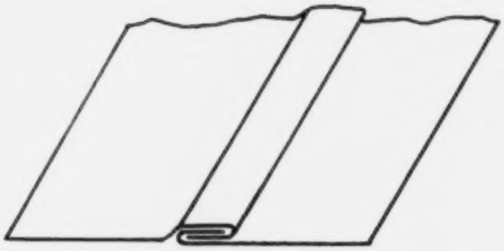
  - Butt seam — Used when two pieces of metal are joined without overlapping; can be soldered or welded (Figure 24)

FIGURE 24



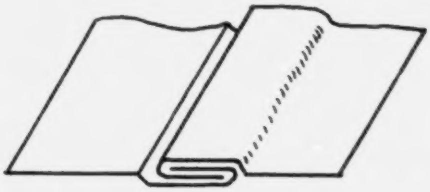
- Grooved lock seam — Formed on a brake so that two hems can be clipped together and closed with a hand groover (Figure 25)

FIGURE 25



- Acme or hammerlock pipe seam — Formed on a lock former, then clipped together and hammered down with a mallet; used when making long lengths of round pipe (Figure 26)

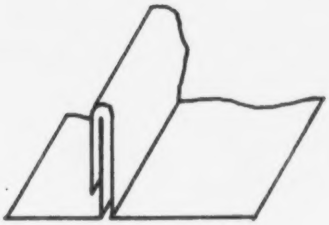
FIGURE 26



- Standing seam — Used to support edges of long spans such as metal roofs, awnings, and canopies (Figure 27)

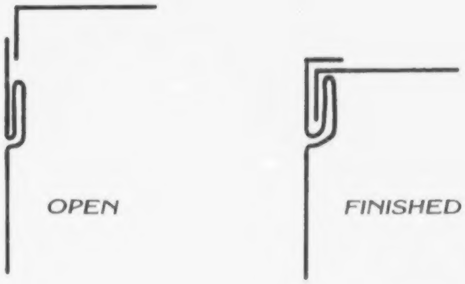
  NOTE: Standing seams require waterproofing and should be secured with solder or rivets.

FIGURE 27



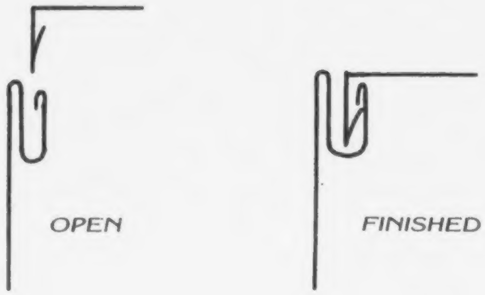
- Pittsburgh seam — Formed on a Pittsburgh machine or made on a brake; most commonly used on rectangular duct (Figure 28)

FIGURE 28



- Snap-lock Pittsburgh seam — Used on rectangular duct in high production applications; formed on a special Pittsburgh machine and put together by hand or with a mallet (Figure 29)

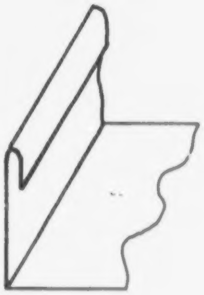
FIGURE 29



- Hems

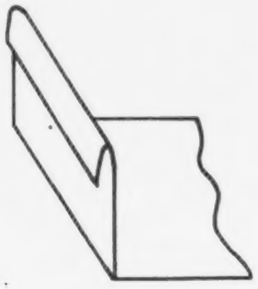
  - Inside hem — Formed on a brake or bar folder with a small amount of metal turned down 180-degrees on the inside to form a smooth edge and add strength and stiffness (Figure 30)

FIGURE 30



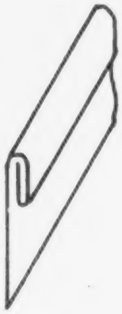
- Outside hem — Formed on a brake or bar folder with a small amount of metal turned down 180-degrees on the outside to form smooth edge and add strength and stiffness (Figure 31)

FIGURE 31



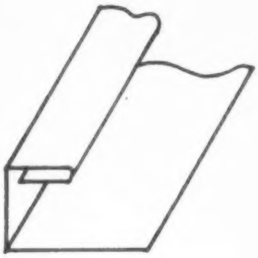
- Double hem — Formed like a single hem, but doubled when extra support is required (Figure 32)

FIGURE 32



- Standing hem — A hem with an added 90-degree angle to add strength and stiffness for supporting or shaping (Figure 33)

FIGURE 33

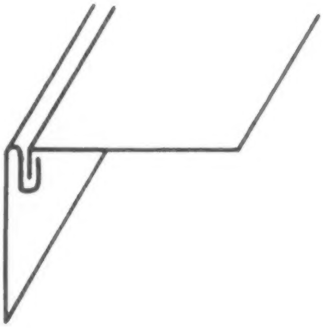


- Locks

  - Coffin lock — Used to form a neat, square outside corner in an application where the inside is hidden and does not require special finishing (Figure 34)

    EXAMPLE: On a canopy where the outside is exposed, coffin locks can be soldered and neatly finished to form a neat-looking hidden seam.

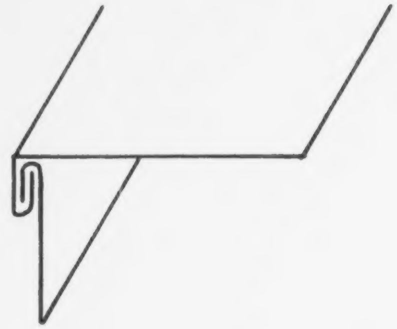
FIGURE 34



- Sliplock — Used to form a neat square, inside corner in an application where the outside is not critical and does not require special finishing (Figure 35)

  EXAMPLE: The bottoms of many pans are formed with sliplocks.

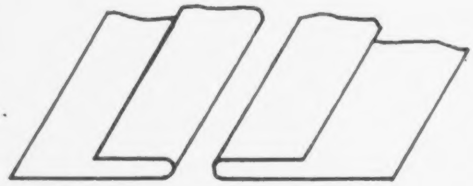
FIGURE 35



- Clips

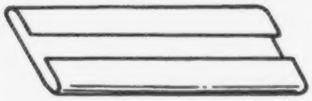
  - Edges for connecting drive clips — ½-inch edge formed with a cleat bender on the short side of preformed duct (Figure 36)

FIGURE 36



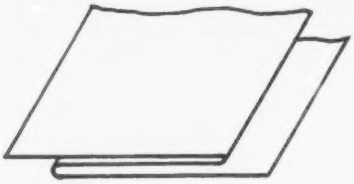
- Drive clip — Usually hammered onto the preformed edges of duct to hold two pieces of duct together (Figure 37)

FIGURE 37



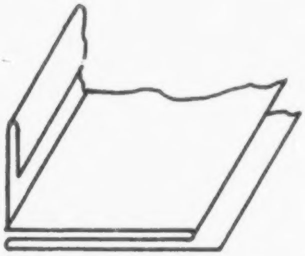
- S-clip — Shaped somewhat like the letter "S" and used along the long side of pieces of duct to join them together and to prevent loss of air at these points (Figure 38)

FIGURE 38



- Standing hem S-clip — Used for providing extra support in applications of extra-wide duct (Figure 39)

FIGURE 39



- Notches
  - Corner notch — Used on corners of boxes and pans when the sides ben 90-degrees from the bottom
  - Lap notch — A notch angled 20- to 30-degrees; designed to overlap corners; usually secured by spot welding or riveting
  - Duct notch — A notch angled at approximately 30 degrees; used on all corners and sides of duct work
  - 45-degree lap notch — A notch angled at exactly 45 degrees to give a picture frame appearance
  - Center Pittsburgh notch — A 30-degree V-shaped notch made on the Pittsburgh side where the metal will be bent across a seam

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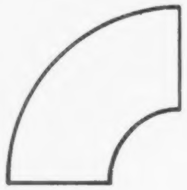
CAUTION: To avoid leaving a hole in the finished application, *never* cut full depth.

  - Corner Pittsburgh notch for transitional duct — A 30-degree notch ½ inch deep angling into a straight notch which joins the seam allowance line only on transitional duct
  - Dovetail notch — Used for connecting round pipe to a rectangular duct or flat sheet

OBJECTIVE 5 **Given drawings, recognize basic types of sheet metal fittings.**

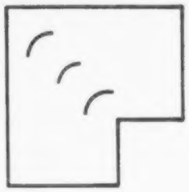
- Sheet metal fittings
  - Curved-throat elbow

FIGURE 40



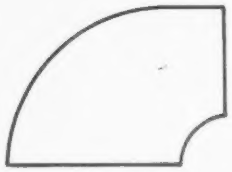
  - Square-throat elbow

FIGURE 41



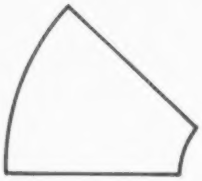
  - Change elbow

FIGURE 42



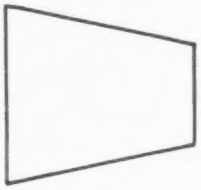
  - Angle

FIGURE 43



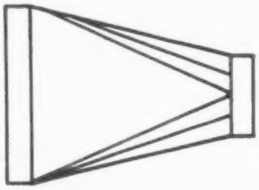
  - Transition

FIGURE 44



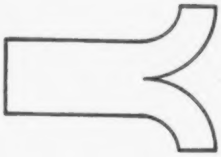
  - Square to round transition

FIGURE 45



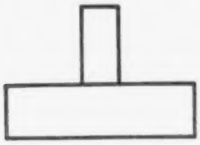
— Y-branch

FIGURE 46



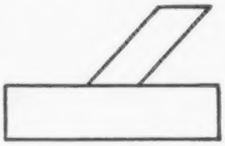
— Tee

FIGURE 47



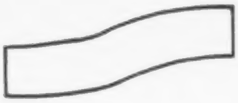
— Angle tee

FIGURE 48



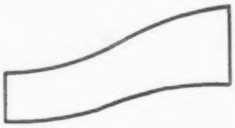
— Offset

FIGURE 49



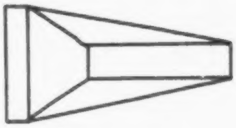
— Change offset

FIGURE 50

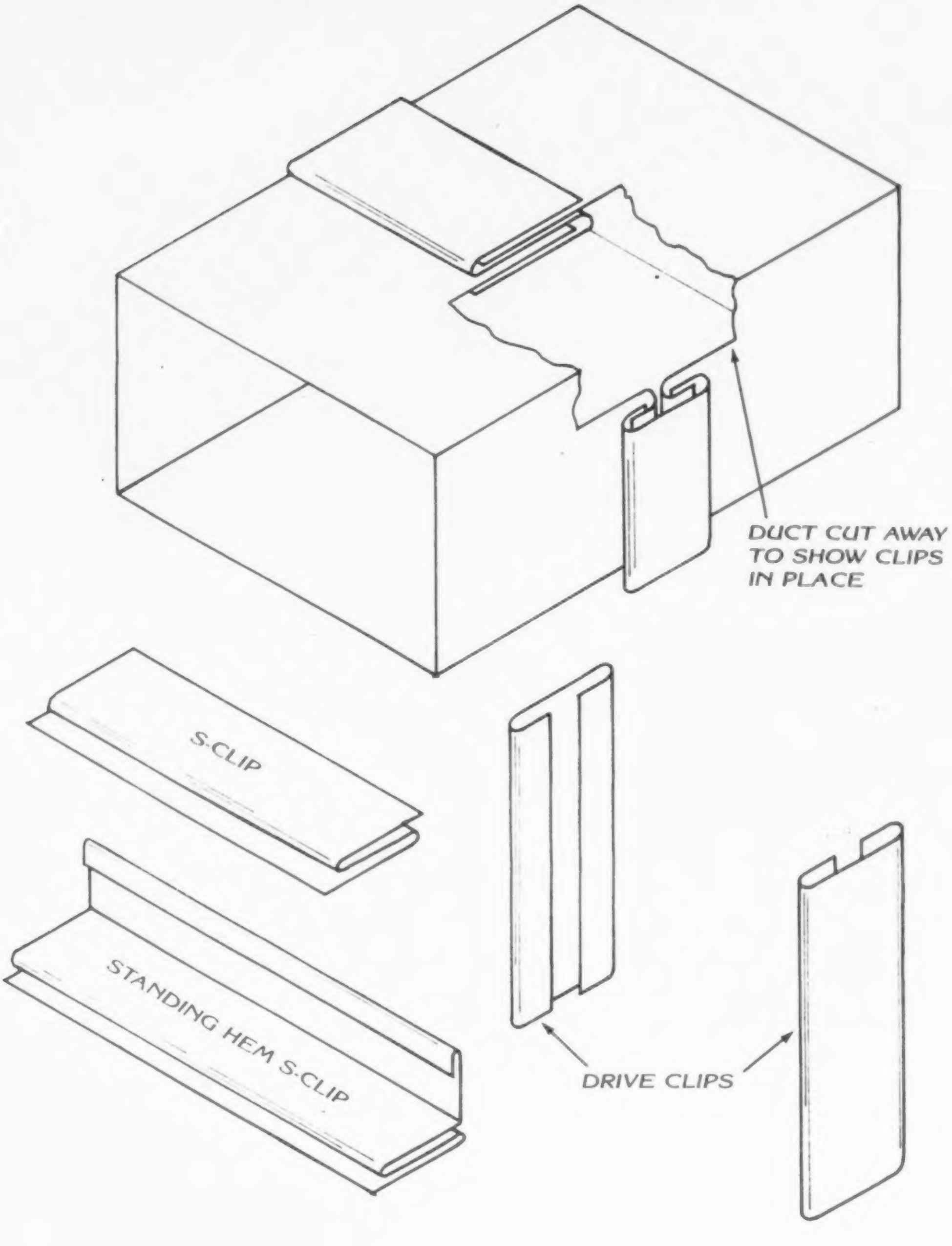


— Boot

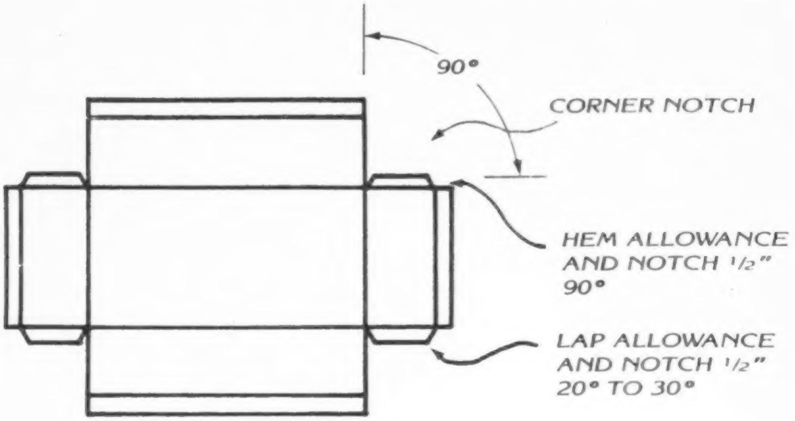
FIGURE 51

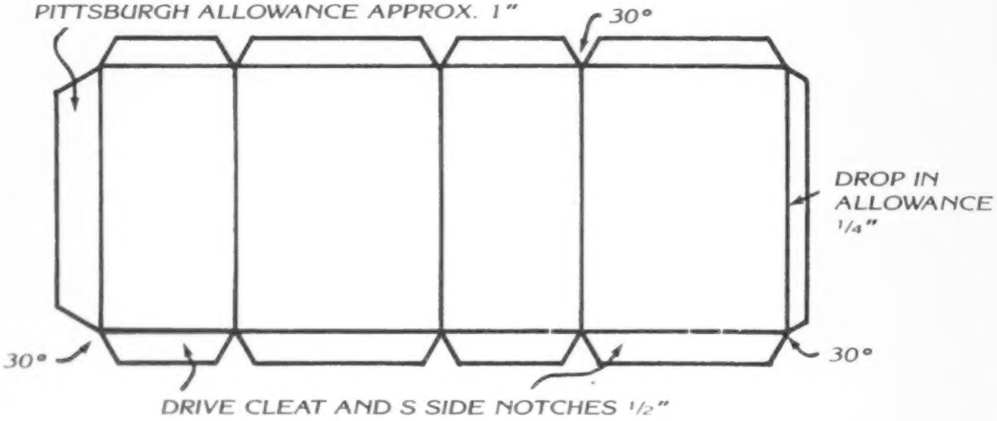


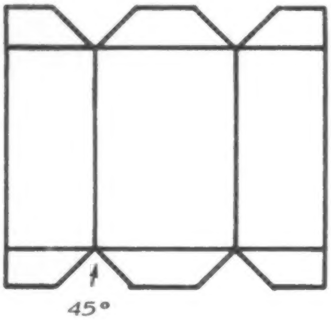
Duct Installation Using S and Drive Clips


DUCT CUT AWAY TO SHOW CLIPS IN PLACE
S-CLIP
STANDING HEM S-CLIP
DRIVE CLIPS

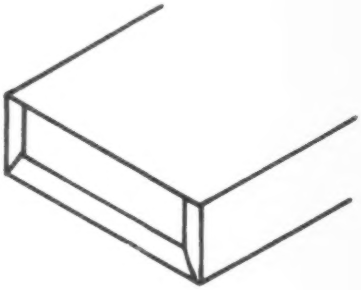
Types of Notches


90°
CORNER NOTCH
HEM ALLOWANCE AND NOTCH 1/2" 90°
LAP ALLOWANCE AND NOTCH 1/2" 20° TO 30°


PITTSBURGH ALLOWANCE APPROX. 1"
30°
DROP IN ALLOWANCE 1/4"
30°
30°
DRIVE CLEAT AND S SIDE NOTCHES 1/2"



LAP SEAM FOR 3-PIECE BOX

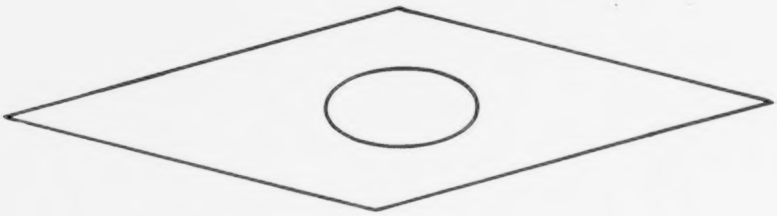


FINISHED SEAM

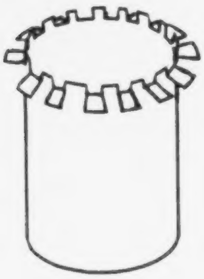
votech

TM 3

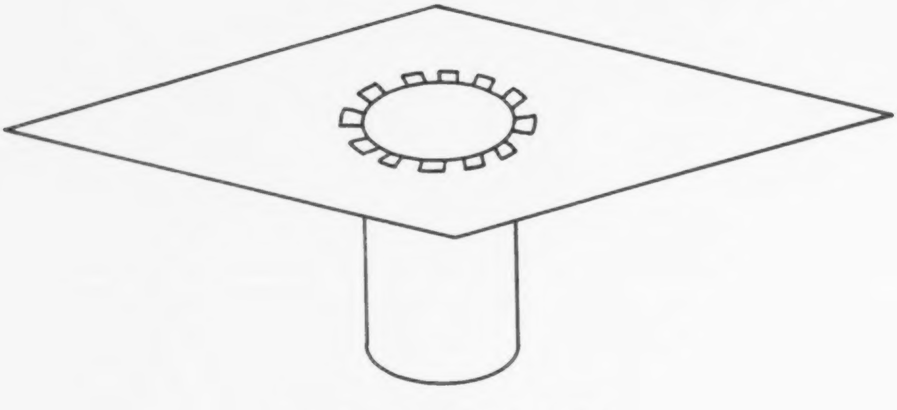
Dovetail Notch in Cylinder to Flat Surface Application



HOLE FOR DOVETAIL



DOVETAIL NOTCH



FINISHED DOVETAIL SEAM

ASSIGNMENT SHEET 1

APPLIED SKILLS

A 3

Name ______________________ Score ________

OBJECTIVE 3

Perform basic sheet metal layout procedures.

INTRODUCTION

Use this exercise to practice preparations to lay out and cut sheet metal.

EQUIPMENT AND SUPPLIES

- Straightedge or ruler
- Compass
- Pencil

INSTRUCTIONS

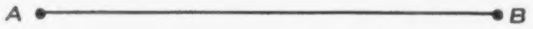
Use the steps from the information sheets to compute and draw the geometric symbols.

Functional Reading
- Follow written instructions
- Interpret graphics and symbols

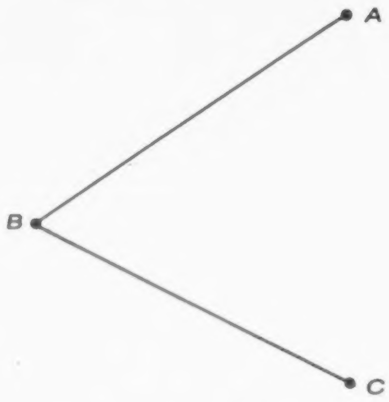
Math Application
- Apply geometry principles

General Science
- Use scientific instruments

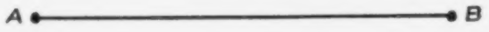
1. Bisect line AB.



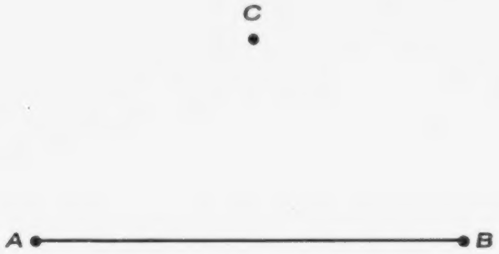
2. Bisect the angle ABC.



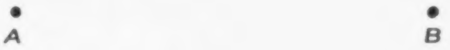
3. Draw a perpendicular above the line AB at point B.



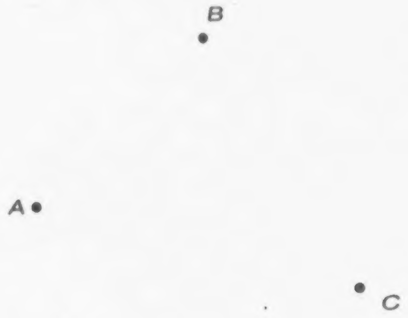
4. Draw a perpendicular from point C to line AB.



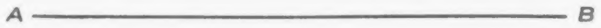
5. Pass an arc with a 2" radius through points A and B.



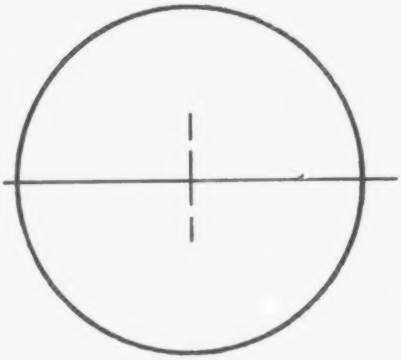
6. Pass an arc through the three points A, B, and C.



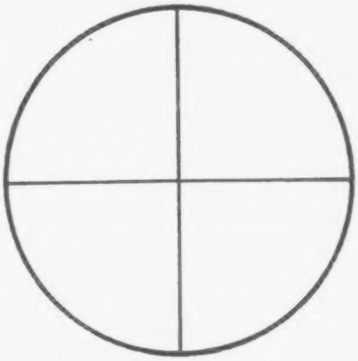
7. Divide the line AB into seven equal parts.



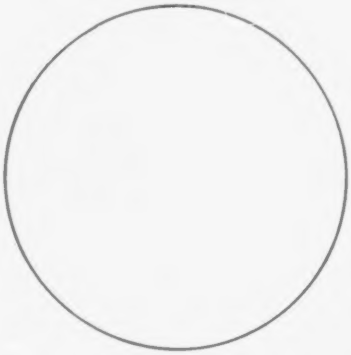
8. Divide the given circle into six equal parts.



9. Construct a line parallel to and 1″ above line AB.



10. Find the center of the given circle.



ASSIGNMENT SHEET 2

APPLIED SKILLS A 3

Name ______________________________ Score __________

OBJECTIVE 4

Identify basic methods for interlocking or joining sheet metal.

INTRODUCTION

This exercise will ask you to identify and match hardware and methods of joining sheet metal.

EQUIPMENT AND SUPPLIES

None

INSTRUCTIONS

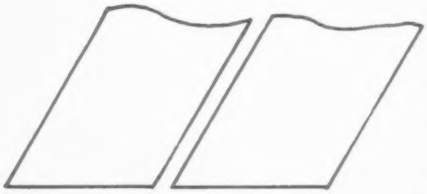
Functional Reading
- Follow written instructions

Job Acquisition/ Development
- Master specific job task/procedure

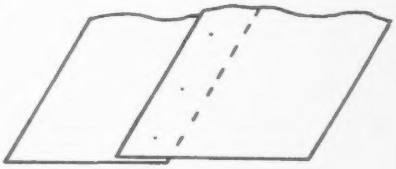
In the blank lines below the drawings, write in the correct titles.

Part 1 — Seams

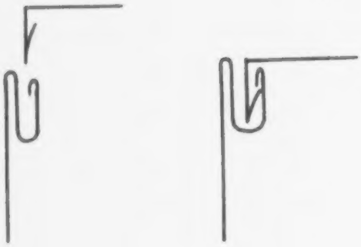
Lap seam
Standing seam
Butt seam
Grooved lock seam
Acme or hammerlock pipe seam
Pittsburgh seam
Snap-lock Pittsburgh seam



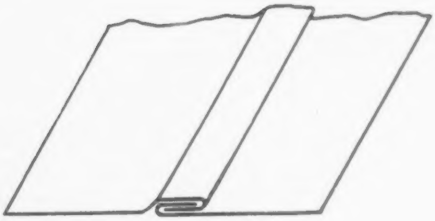
1. ____________________



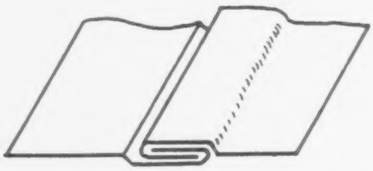
2. ____________________



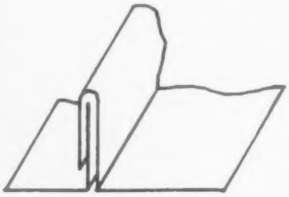
3. ____________________



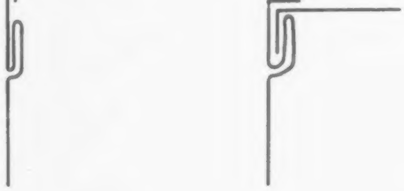
4. ____________________



5. ____________________



6. ____________________

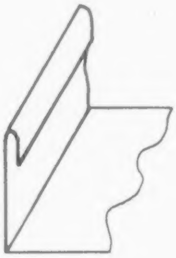


7. ____________________

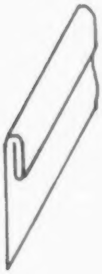
Part 2 — Hems

Outside hem
Double hem

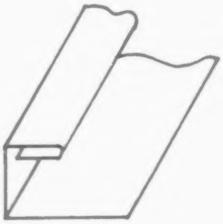
Standing hem
Inside hem



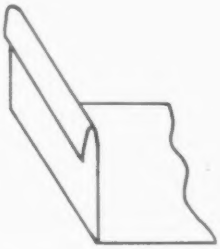
1. ______________________



2. ______________________



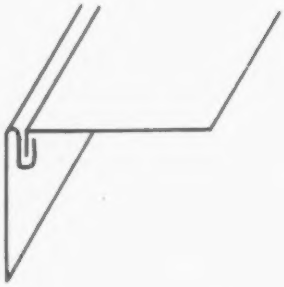
3. ______________________



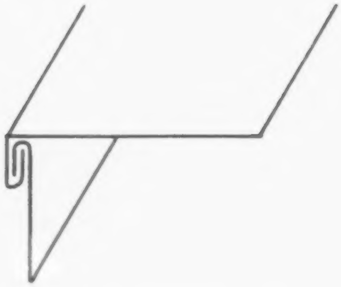
4. ______________________

Part 3 — Locks

Sliplock
Coffin lock



1. ______________________

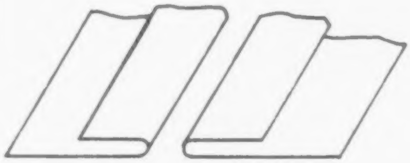


2. ______________________

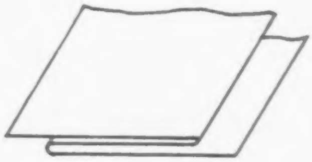
Part 4 — Clips

Standing hem S-clip
S-clip

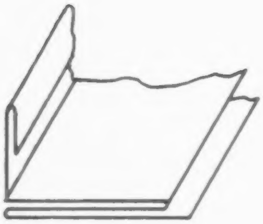
Edges of connecting drive clips
Drive clip

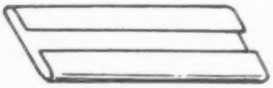


1. ______________________



2. ______________________





3. ____________________ 4. ____________________

Part 5 — Notches

INSTRUCTIONS

Match these basic types of notches to their descriptions.

_____ 1. Used for connecting round pipe to a rectangular duct or a flat sheet

_____ 2. A 30-degree notch ½ inch deep angling into a straight notch which joins the seam allowance line only on transitional duct

_____ 3. A notch angled at approximately 30 degrees; used on all corners and sides in duct work

_____ 4. Used on corners of boxes and pans when the sides bend 90 degrees from the bottom

_____ 5. A 30-degree V-shaped notch made on the Pittsburgh side where the metal will be bent across a seam

a. Duct notch

b. Center Pittsburgh notch

c. Lap notch

d. Dovetail notch

e. Corner notch

f. 45-degree lap notch

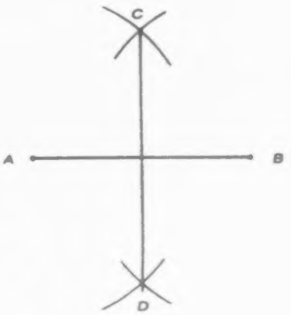
g. Corner Pittsburgh notch for transitional duct

_____ 6. A notch angled at exactly 45 degrees to give a picture frame appearance

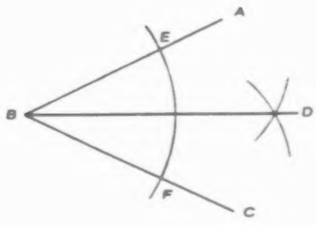
_____ 7. A notch angled 20 to 30 degrees; designed to overlap corners; usually secured by spot welding or riveting

ASSIGNMENT SHEET 1

1.



2.



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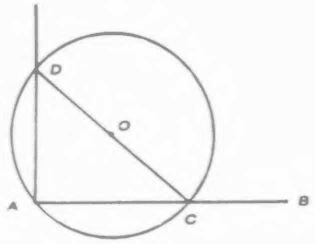

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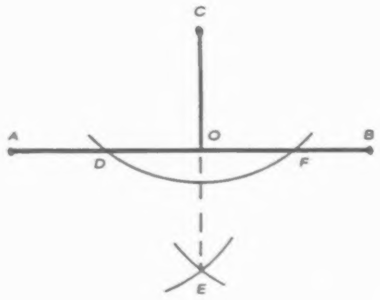

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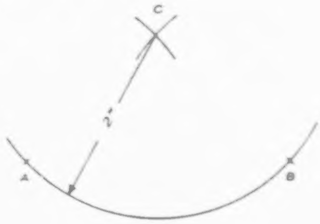

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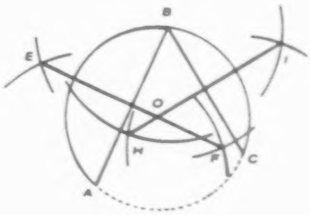
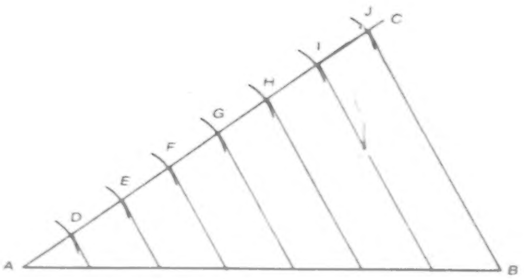
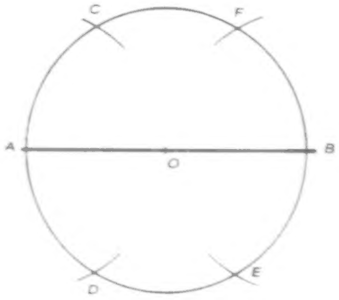


7.



J
C
I
H
G
F
E
D
A
B

8.



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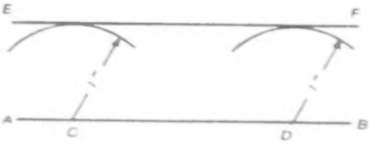

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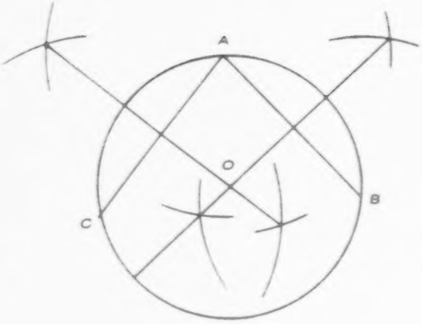


ASSIGNMENT SHEET 2

Part 1

1. Butt seam
2. Lap seam
3. Snap-lock Pittsburgh seam
4. Grooved lock seam
5. Acme or hammerlock pipe seam
6. Standing seam
7. Pittsburgh seam

Part 2

1. Inside hem
2. Double hem
3. Standing hem
4. Outside hem

Part 3

1. Coffin lock
2. Sliplock

Part 4

1. Edges for connecting drive clips
2. S-clip
3. Standing hem S-clip
4. Drive clip

Part 5

1. d
2. g
3. a
4. e
5. b
6. f
7. c

JOB SHEET 1

APPLIED SKILLS

A 3

OBJECTIVE 6

Lay out and cut sheet metal to a rectangle.

INTRODUCTION

This exercise allows you to practice the lay out and cutting of a basic sheet metal pattern. This is a basic skill required in developing techniques for cutting sheet metal.

TOOLS AND EQUIPMENT

- Leather gloves and goggles
- Straight snips
- Circumference rule
- Scratch awl
- 26-gauge galvanized metal as selected by instructor

PROCEDURE

	Yes	No
1. Put on safety equipment.	___	___
2. Using a circumference rule, measure and scribe a 4″ × 3″ rectangle on the galvanized sheet.	___	___
NOTE: You may be working with scrap, but even so, avoid wasting metal.		
3. Place the snips over one edge of the metal until the metal reaches the V in the snip jaws.	___	___

Functional Reading
- Follow written instructions

General Science
- Use scientific instruments

Job Acquisition/ Development
- Master specific job task/procedure

	Yes	No
4. Begin cutting, but be careful not to make full cut; in other words, cut about three-fourths the length of the snip jaws.	___	___
NOTE: This is the first step in developing good cutting techniques; making a full stroke of the jaws with the snips will leave a fishhook at the end of the cut.		
5. Continue cutting with the jaws making short strokes until reaching the end of the scribe line or the end of the metal.	___	___
6. Repeat the same cutting procedure on the other side of the layout.	___	___
7. Continue cutting the layout until the 4″ × 3″ rectangle has been cut out, making smooth, short cuts with the straight snips to avoid leaving fishhooks.	___	___
8. Inspect the rectangle for clean edges, then have your instructor check your work.	___	___
9. Return tools and materials to proper storage areas.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS ____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Properly used safety equipment	4	3	2	1
Metal cut to size (± 1/16")	4	3	2	1
Used snips properly	4	3	2	1
Clean edges	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** Can perform job with no additional training
3 **Moderately Skilled** Has performed job during training program; limited additional training may be required
2 **Limited Skill** Has performed job during training program; additional training is required to develop skill
1 **Unskilled** Is familiar with process, but is unable to perform job

JOB SHEET 2 APPLIED SKILLS A 3

OBJECTIVE 7 **Lay out and cut a circle in sheet metal.**

INTRODUCTION The lay out and cutting of a circle in sheet metal requires your use of several important techniques and sheet metal tools.

TOOLS AND EQUIPMENT

- Goggles and leather gloves
- Left-cutting snips
- Wing dividers
- Scratch awl
- Circumference rule
- 26-gauge galvanized metal

PROCEDURE

Yes No

1. Put on safety equipment. ___ ___
2. Using the circumference rule, adjust the wing dividers for the layout of a 3-inch circle. ___ ___
3. Measure and scribe a 3-inch circle on the galvanized sheet. ___ ___

   NOTE: Avoid wasting material.

4. Place the left-cutting snips over an appropriate starting point until the metal reaches the V in the snips jaws. ___ ___

   NOTE: Twist the left-cutting snips firmly to the right to keep from ruining the snips.

Functional Reading
- Follow written instructions

General Science
- Use scientific instruments

Job Acquisition/ Development
- Master specific job task/procedure

Yes No

5. Begin cutting, but be careful not to make a full cut; in other words, cut about three-fourths the length of the snips jaws. ___ ___

6. Continue cutting, keeping continuous pressure to the right, and in short, firm strokes until the circle is completely cut out. ___ ___

7. Inspect the circle for clean edges, then have your instructor check your work. ___ ___

8. Return tools and materials to proper storage areas. ___ ___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS ______________________________

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Properly used safety equipment	4	3	2	1
Properly used tools for layout	4	3	2	1
Circle cut to proper size (± $\frac{1}{16}$")	4	3	2	1
Circle has clean edges	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** Can perform job with no additional training

3 **Moderately Skilled** Has performed job during training program; limited additional training may be required

2 **Limited Skill** Has performed job during training program; additional training is required to develop skill

1 **Unskilled** Is familiar with process, but is unable to perform job

OBJECTIVE 8

Lay out and form a metal box.

INTRODUCTION

In this exercise you will expand your use of sheet metal tools and apply your skills in using specifications to form a small metal box.

TOOLS AND EQUIPMENT

- Goggles and leather gloves
- Scratch awl
- Steel tape
- Straightedge
- Bulldog snips
- Right- and left-cutting snips
- Rivet set or pop-rivet gun
- Sheet metal hammer
- Floor and hand tools as required for finishing
- Sheet metal as selected by instructor

PROCEDURE

Functional Reading
- Follow written instructions

General Science
- Use scientific instruments

	Yes	No
1. Put on safety equipment.	___	___
2. Use the attached specifications to lay out a 6″ (l) × 2″ (h) × 4″ (w) metal box (Figures 52 and 53).	___	___
3. Use a steel tape, the straightedge, and awl to lay out the metal box pattern on a 9″ × 11″ area of sheet metal.	___	___
4. Cut out pattern as indicated.	___	___

votech

Job Acquisition/ Development

- Master specific job task/procedure

Yes No

5. Select hand or floor tools appropriate to specifications and form and finish the box. ___ ___

   NOTE: When in doubt about tool selection or forming procedure, ask your instructor for assistance.

6. Drill holes for rivets; ask your instructor for assistance in selecting the drill bit size to match the rivets used. ___ ___

7. Have your instructor check your work. ___ ___

8. Return tools and materials to proper storage areas. ___ ___

FIGURE 52 — Isometric view

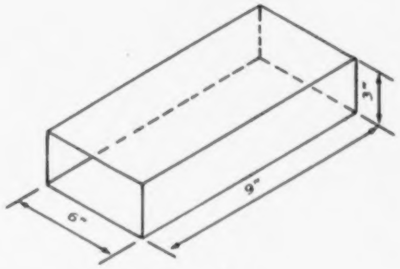
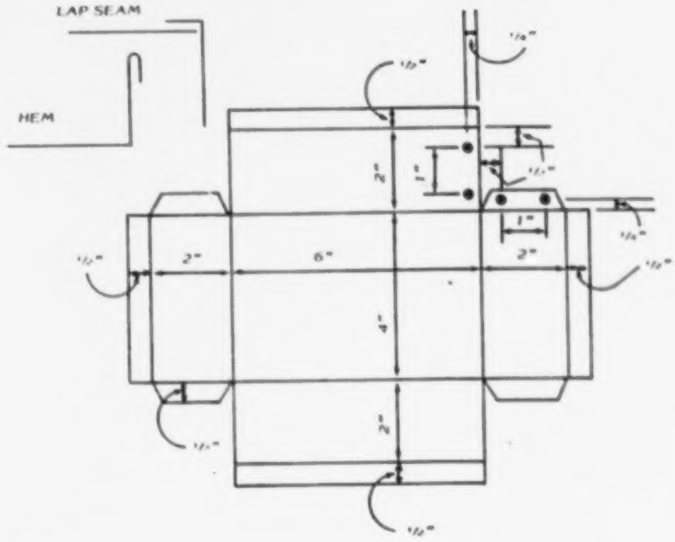


FIGURE 53 — Specifications


LAP SEAM
HEM
1/4"
1/2"
1/2"
1"
2"
1"
1/4"
1/2"
2"
6"
2"
1/2"
4"
1/2"
2"
1/2"

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS ____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Properly used safety equipment	4	3	2	1
Lay out box correctly (± 1/16")	4	3	2	1
Used proper snips	4	3	2	1
Formed box at layout marks	4	3	2	1
Edges clean	4	3	2	1
Rivets set securely	4	3	2	1

EVALUATOR'S COMMENTS

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** Can perform job with no additional training

3 **Moderately Skilled** Has performed job during training program; limited additional training may be required

2 **Limited Skill** Has performed job during training program; additional training is required to develop skill

1 **Unskilled** Is familiar with process, but is unable to perform job

OBJECTIVE 9

Lay out and form a rectangular duct.

INTRODUCTION

The layout and forming of rectangular ducts is a requirement for those sheet metal workers installing heating and air conditioning systems.

TOOLS AND EQUIPMENT

- Goggles and leather gloves
- Scratch awl
- Steel tape
- Straightedge
- Bulldog snips
- Right- and left-cutting snips
- Square
- Sheet metal hammer
- Sheet metal as selected by instructor
- Floor and hand tools as required for finishing

PROCEDURE

	Yes	No
1. Put on safety equipment.	___	___
2. Use the specifications to lay out a 9" (l) × 3" (h) × 6" (w). (Figures 54 and 55).	___	___

Functional Reading
- Follow written instructions

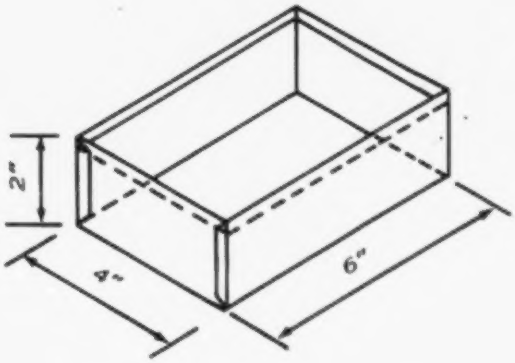
General Science
- Use scientific instruments

Job Acquisition/ Development

- Master specific job task/procedure

Yes No

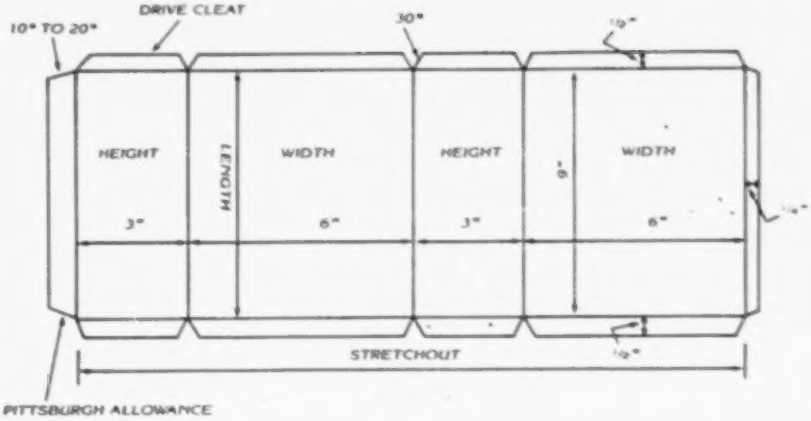
FIGURE 54 — Isometric view



3. Block out 19¼" × 10" area on sheet metal. — —

4. Transcribe all measurements to sheet metal with awl and straightedge. (Figures 54 and 55) — —

FIGURE 55


DRIVE CLEAT
10° TO 20°
30°
½"
HEIGHT
LENGTH
WIDTH
HEIGHT
9"
WIDTH
¼"
3"
6"
3"
6"
STRETCHOUT
½"
PITTSBURGH ALLOWANCE

	Yes	No
5. Cut out pattern with bulldogs, left- and right-cutting snips. (Figure 55)	___	___
6. Select hand or floor tools appropriate to specifications and form and finish the duct.	___	___
NOTE: when in doubt about tool selection or forming procedure, ask your instructor for assistance.		
7. Have your instructor check your work.	___	___
8. Return tools and materials to proper storage areas.	___	___

(End of Job Sheet)

SKILL TEST RECORD

EVALUATOR'S COMMENTS

____

____

____

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Performance Evaluation Key.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:				
Properly used safety equipment	4	3	2	1

Lay out duct to proper size (± 1/16″)	4	3	2	1
Used tools properly	4	3	2	1
Edge clean	4	3	2	1
Duct joints formed properly	4	3	2	1

EVALUATOR'S COMMENTS

____

____

____

AVERAGE RATING

Evaluator note: To obtain an average rating for the Competency Profile, total the designated points in "Product Evaluation" and divide by the total number of criteria. Circle the rating on the "Performance Evaluation Key" below.

PERFORMANCE EVALUATION KEY

4 **Skilled** Can perform job with no additional training
3 **Moderately Skilled** Has performed job during training program; limited additional training may be required
2 **Limited Skill** Has performed job during training program; additional training is required to develop skill
1 **Unskilled** Is familiar with process, but is unable to perform job

WRITTEN TEST

APPLIED SKILLS A 3

Name ______________________________ Score ________

OBJECTIVE 1

Given a list of terms associated with sheet metal skills, match them to their correct definition. Circle the letter that corresponds to the most correct answer.

_____ 1. Which of the following terms is used to define the distance between the outer edges of a circle through its center point?

a. Circumference
b. Area
c. Perimeter
d. Diameter

_____ 2. The procedure or method by which two pieces of metal are joined is called to

a. tab
b. seam
c. edge
d. bond

_____ 3. The sheet metal edge that is formed to add strength is known as a

a. seam
b. notch
c. hem
d. chord

_____ 4. The distance from the center of a circle to any point on its edge is called its

a. chord
b. radius
c. perimeter
d. diameter

May be photocopied for student use.

_____ 5. An angle cut in the edge of a piece of metal to facilitate the forming of seams, hems, and joints is called a

a. notch
b. clip cut
c. block out
d. lineal cut line

_____ 6. Two lines that extend in the same direction an equal distance apart and never meet are said to be

a. an arc
b. equilateral
c. parallel
d. tangent

_____ 7. A piece of metal formed specifically for holding two or more sections of ducts together is called a

a. notch
b. clip
c. seam lock
d. tab

_____ 8. An angle formed by two lines perpendicular to each other is known as a

a. right angle
b. lineal angle
c. tangent
d. ellipse angle

_____ 9. A segment of a circle is called a

a. chord
b. square
c. arc
d. segmentation area

_____10. To divide an object into two equal parts is to

a. trisect it
b. lineal divide it
c. chord it
d. bisect it

May be photocopied for student use.

_____11. Material intended to be bent for an anchoring point or as a lap allowance is known as a

a. joint
b. tab
c. clip
d. lock

_____12. Shapes that are formed by straight or curved lines are known as being

a. perpendicular
b. geometric
c. equilateral
d. tangent

_____13. The outer limits or boundary is called the

a. perimeter
b. circumference
c. diameter
d. seam point

_____14. The Greek letter that represents to ratio of a circle's circumference to its diameter is called

a. sin
b. chi
c. tan
d. pi

_____15. A measure of a flat surface, expressed in square units, is

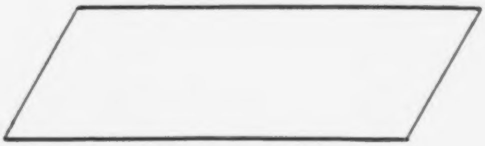
a. length
b. width
c. area
d. height

May be photocopied for student use.

OBJECTIVE 2

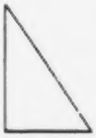
Match geometric figures to their correct titles.

_____ 1. The figure below represents a



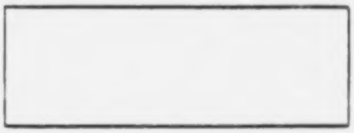
a. rhombus
b. rectangle
c. parallelogram
d. right angle

_____ 2. The figure illustrated below is a



a. square
b. triangle
c. rectangle
d. rhombus

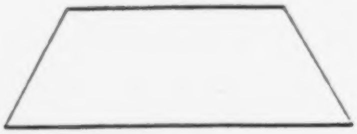
_____ 3. The geometric figure shown is a



a. rectangle
b. square
c. parallelogram
d. trapezoid

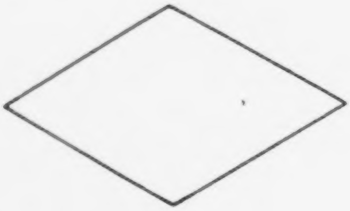
May be photocopied for student use.

_____ 4. The title of the figure shown below is a



a. trapezoid
b. rectangle
c. square
d. rhombus

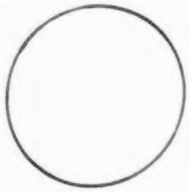
_____ 5. This figure represents a



a. square
b. parallelogram
c. rectangle
d. rhombus

May be photocopied for student use.

_____ 6. The drawing below represents a/an



a. arc
b. ring angle
c. circle
e. parallelogram

NOTE: Objectives 3-9 are evaluated on job sheets/assignment sheets in this unit. If you have not completed these components, see your instructor.

May be photocopied for student use.

WRITTEN TEST ANSWERS

APPLIED SKILLS A 3

OBJECTIVE 1

1. d
2. b
3. c
4. b
5. a
6. c
7. b
8. a
9. c
10. d
11. b
12. b
13. a
14. d
15. c

OBJECTIVE 2

1. c
2. b
3. a
4. a
5. d
6. c

CIMC
TEST CODE SHEET

VOCATIONAL PROGRAM (BOOK TITLE) INTRODUCTION TO SHEET METAL

UNIT NUMBER AND TITLE – A3 – APPLIED SKILLS

TOTAL NUMBER OF TEST QUESTIONS 21

TOTAL NUMBER OF BASIC SKILL QUESTIONS 16

OBJECTIVE NUMBER	TEST QUESTION NUMBER(S)	BASIC SKILL CODE(S)
1	**1, 4, 6, 8-10, 12-15**	**M**
1	**2, 3, 5, 7, 11**	**X**
2	**1-6**	**M**

INTRODUCTION TO SHEET METAL
COMPETENCY PROFILE

Student ______________________ ______________________ Soc. Sec. No. ____ – ____ – ____
Last First MI

PROGRAM
Grade 9 10 11 12 Adult
SCHOOL

INSTRUCTOR
SCHOOL ADDRESS
PHONE

STUDENT'S HOME ADDRESS
DATE OF BIRTH
PHONE

STUDENT'S EMPLOYER
ADDRESS
PHONE

CONTACT IN CASE OF EMERGENCY
PHONE

ADDRESS

OR

ADDRESS
PHONE

The above information can be used for school records and/or to ensure safety of students. This confidential information is not to be released to employers or to the general public.

ON-THE-JOB TRAINING/WORK EXPERIENCE

DURATION OF EMPLOYMENT	JOB TITLE	EMPLOYER	SUPERVISOR'S NAME	ADDRESS OF EMPLOYER	PHONE

This agency does not discriminate on the basis of race, creed, color, national origin, sex, age, veteran status, qualified handicap, or disability.

Duplicate one copy for each student.

SPECIFIC JOB COMPETENCIES

DIRECTIONS: Evaluate the trainee using the rating scale below, and check the appropriate number to indicate the degree of competency. The numerical ratings of 4, 3, 2, 1, and 0 are not intended to represent the traditional school grading system of A, B, C, D, and F. The descriptions associated with each of the numbers focus on level of student performance for each of the tasks listed below.

Rating Scale:
4 — **Skilled** — can perform job independently with no additional training
3 — **Moderately Skilled** — has performed job independently during the training program; limited additional training may be required
2 — **Limited Practice** — has practiced job during training program; additional training is required to develop skill
1 — **Exposure Only** — general information provided with no practice time; close supervision needed and additional training required
0 — **No Exposure** — no information or practice provided during training program; complete training required

UNIT A1

4	3	2	1	0	
					Sheet Metal Material
☐	☐	☐	☐	☐	1 Given a list of terms associated with sheet metal materials, match them to their correct definitions
☐	☐	☐	☐	☐	2 Given a physical description, identify sheet metal types
☐	☐	☐	☐	☐	3 Given a list of metal types, choose the typical use or major characteristic
☐	☐	☐	☐	☐	4 Identify the most common sheet metal interlocking methods and fastening hardware
☐	☐	☐	☐	☐	5 Given alternatives, select the correct safety rules for handling large sheets of metal
☐	☐	☐	☐	☐	6 Identify metals by sight and feel
☐	☐	☐	☐	☐	7 Lift and move a large sheet of metal using the proper safety rules
☐	☐	☐	☐	☐	8 ______________________________

WRITTEN TEST SCORE ______________________

UNIT A2

4	3	2	1	0	
					Sheet Metal Tools
☐	☐	☐	☐	☐	1 Given a list of terms associated with sheet metal tools, match them to their correct definitions
☐	☐	☐	☐	☐	2 Given drawings, match sheet metal tools to their use
☐	☐	☐	☐	☐	3 Match drawings to the correct use of sheet metal power tools
☐	☐	☐	☐	☐	4 Given a drawing, identify common tools used to finish drywall
☐	☐	☐	☐	☐	5 Given a list of sheet metal tools, match them to their correct use
☐	☐	☐	☐	☐	6 Provided with common sheet metal tools, identify them by their appearance
☐	☐	☐	☐	☐	7 Use a circumference rule to perform measurements
☐	☐	☐	☐	☐	8 ______________________________

WRITTEN TEST SCORE ______________________

UNIT A3

4	3	2	1	0	
					Applied Skills
☐	☐	☐	☐	☐	1 Given a list of terms associated with sheet metal skills, match them to their correct definitions
☐	☐	☐	☐	☐	2 Match geometric figures to their correct titles
☐	☐	☐	☐	☐	3 Perform basic sheet metal layout procedures
☐	☐	☐	☐	☐	4 Identify basic methods for interlocking or joining sheet metal
☐	☐	☐	☐	☐	5 Given drawings, recognize basic types of sheet metal fittings
☐	☐	☐	☐	☐	6 Lay out and cut sheet metal to a rectangle
☐	☐	☐	☐	☐	7 Lay out and cut a circle in sheet metal
☐	☐	☐	☐	☐	8 Lay out and form a metal box
☐	☐	☐	☐	☐	9 Lay out and form a rectangular duct
☐	☐	☐	☐	☐	10 ______________________________

WRITTEN TEST SCORE ______________________

BEST COPY AVAILABLE

Use of This Document

Use of this document can be used to record information about the student and the skills mastered by the student. This information is useful in documenting student progress during the training program and to provide information about the student's qualifications to potential employers and for entry into advanced training programs. Instructors using AGC-CIMC instructional materials are authorized to reproduce this document as required for use in their training programs.

INTRODUCTION TO SHEET METAL

CIM

READING SKILLS

WRIT

UNITS OF INSTRUCTION	Reading Comprehension									Research and Reference								Functional Reading						Language		Composition							
	Gain factual information	Distinguish fact, opinion and inference	Recognize stereotyping and bias	Recognize propaganda	Analyze cause and effect	Draw conclusions	Make generalizations	React to written material	Apply word analysis techniques	Select useful resources	Locate resources	Find materials in library	Use standard references	Use in-book reference tools	Use audiovisual media	Use computer data base	Use magazines and newspapers	Interpret forms and records	Follow written instructions	Interpret graphics and symbols	Use content area vocabulary	Interpret abbreviations/acronyms	Read aloud	Use standard grammar and correct spelling, punctuation, and capitalization	State ideas clearly	Use complete sentences	Develop preliminary outline	Use topic sentences	Use introductory/closing paragraphs	Compose reports	Compose essays	Proofread and edit	Construct graphics and symbols
Sheet Metal Material																			●														
Sheet Metal Tools																			●														
Applied Skills																			●	●													

IMC BASIC SKILLS DOCUMENTATION MATRI

WRITING SKILLS

MATH SKILLS

		Research					Functional Writing							Operation and Calculation														Math Application											Data Analysis and Display											
Proofread and edit	Construct graphics and symbols	Take notes	Use notecards	Create bibliography	Use footnotes	Outline material	Complete forms and records	Write instructions	Write letters	Write job applications	Write resumes	Use word processing	Use computer graphics	Round off numbers	Estimate answers	Use scientific notations	Use exponential notations	Calculate with whole numbers	Calculate with fractions	Calculate with decimals	Convert whole numbers to fractions	Convert whole numbers to decimals	Solve numerical expressions	Solve formulae and equations	Obtain squares and square roots	Convert units of measure	Perform metric calculations	Solve word problems	Select/apply mathematical formula	Select/apply mathematical procedure	Use English and metric measures	Solve time/rate/distance problems	Solve ratio/proportion problems	Solve percent problems	Apply techniques of scaling	Apply algebra principles	Apply geometry principles	Apply trigonometry principles	Interpret charts and tables	Interpret graphs (type)	Collect /record data	Apply sampling techniques	Apply principles of probability	Construct charts and tables	Construct graphs	Calculate statistics	Interpret statistics	Interpret blueprints/plans	Make measurements	Perform banking transactions
							●																																											
							●																																●											
																																					●													

X

SCIENCE SKILLS

94-010742

Functional Math												General Science									Life Science							Physical Science					Earth Science							
Make change	Solve practical problems	Calculate gross earnings	Solve income/expense problems	Prepare a budget	Calculate interest	Solve interest problems	Calculate sales tax	Determine income tax	Use calculator for computation	Use computer for computation	Use computer spreadsheets	Apply computing skills	Apply scientific method of inquiry	Conduct experiments	Investigate science ethics	Investigate science history	Investigate/apply economics in technology	Use scientific instruments	Investigate/apply technology	Collect specimens	Identify/classify living organisms	Investigate biological history of the earth	Investigate food chains, webs, pyramids	Investigate/apply principles of human development	Investigate/apply principles of genetics/heredity	Investigate/apply principles of anatomy/physiology	Investigate health issues	Analyze/classify matter	Investigate forms/changes of matter	Investigate forms/changes of energy	Investigate/apply chemical properties	Investigate/apply physical laws	Investigate physical characteristics of the earth	Investigate geological history of the earth	Investigate physical forces acting on the earth	Solve problems of longitude, latitude, and time zones	Investigate conservation of physical resources	Investigate conservation of living resources	Investigate issues of environmental impact	Apply science principles to environmental issues
																												●												
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ORAL COMMUNICATION SKILLS

UNITS OF INSTRUCTION	Oral Presentation									Listening				Interactive Communication										General Relating							
	Make informative presentations	Make persuasive presentations	Present personal opinion/viewpoint	Use good speaking techniques	Select/use words effectively	Use effective body language	Present appropriate appearance	Integrate audio and/or visual materials in oral presentations	Adapt presentation to specific audience	Apply active listening skills	Distinguish fact, opinion, and inference	Draw conclusions/make generalizations	Analyze/identify point of view	Give/follow oral directions	Apply questioning techniques	Conduct/receive interviews	Analyze/apply nonverbal communication	Work effectively in a group	Communicate with clients/customers/patients	Communicate with co-workers	Communicate with supervisors	Communicate with professional colleagues/associates	Apply telephone etiquette	Investigate/apply communication process models	Analyze/apply nonverbal communication	Investigate/apply cross-cultural communication	Interact with co-workers	Interact with supervisors	Interact with clients/customers/patients	Interact with professionalcolleagues/associates	Interact with family/friends
Sheet Metal Material																											●				
Sheet Metal Tools																															
Applied Skills																															
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* Use this line for entering your state or local codes for graduation requirements or learner outcomes.

INTERPERSONAL OR RELATING SKILLS																												CREATIVE THINKING/PROBLEM SOLVING SKILLS																				E			
						Teamwork/Cooperation															Leadership/Influence							Cognitive Activities																				Job Sear Selecti			
Interact with professionals/colleagues/associates	Interact with family/friends	Participate in group activities	Participate in industrial relations/functions	Identify personal values/attitudes	Apply information to life experiences	Identify values/attitudes	Identify needs/drives	Select/apply appropriate behavior	Investigate/identify personal styles	Investigate/identify group/corporate climate	Give/receive feedback	Identify hidden purposes	Investigate/apply group dynamics	Control undesirable/inappropriate behavior	Resolve conflicts	Clarify goals/objectives	Devise "win/win" situations	Build consensus	Generate ideas	Present point of view	Analyze/apply leadership styles	Analyze/apply management styles	Obtain confidence of others	Develop esteem in self/others	Persuade others	Analyze/apply motivation techniques	Provide positive coaching	Collect/record information	Identify critical elements/issues	Define a problem	Identify underlying causes	Apply a problem-solving model	Analyze/synthesize information	Identify/analyze underlying assumptions	Draw conclusions	Predict results/outcomes	Identify/evaluate consequences	Identify/develop alternatives	Evaluate alternatives	Select an alternative	Devise a solution	Create a finished product	Apply intuitive/creative thinking processes	Transfer knowledge/training to new situations	Apply new technology	Develop an action plan	Evaluate results/outcomes	Analyze personal occupational aptitudes/preferences	Investigate employment prospects of a career field/occupation	Investigate training requirements for a career field/occupation	Investigate benefits of a career field/occupation
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EMPLOYABILITY SKILLS

Job Search/ Selection								Job Aquisition/ Development													
[illegible] aptitudes/preferences	Investigate employment prospects of a career field/occupation	Investigate training requirements for a career field/occupation	Investigate benefits of a career field/occupation	Compare/evaluate career options	Develop personal career path	Locate appropriate jobs	Analyze duties/requirements/benefits of specific job	Master specific job task/procedure	Fill in job-related applications	Write letter of application	Write personal resume	Interview for a job	Apply business etiquette	Practice good work habits/attitudes	Develop good personal presentation	Develop self-confidence/esteem	Develop effective leadership	Deal effectively with supervisors	Deal effectively with co-workers	Deal effectively with professional colleagues/associates	Deal effectively with customers/clients

SOCIAL STUDIES SKILLS

Information Analysis						Social Studies Application										Functional Social Studies														
Collect/record data	Interpret graphical information	Construct graphical information	Interpret maps/globes	Interpret statistical information	Analyze/interpret demographic information	Investigate/apply U.S. history	Investigate/apply world history	Investigate/apply U.S. geography	Investigate/apply world geography	Investigate/apply principles of government/politics	Investigate/apply principles of economics	Investigate/apply principles of ethics	Investigate/apply principles of psychology	Investigate/apply principles of sociology	Investigate/apply cross-cultural studies	Practice responsible personal economics	Prepare a personal budget	Use credit responsibly	Practice good work ethics	Participate in industrial relations	Interact with people of different races/cultures	Investigate/participate in government	Investigate/apply American legal practices	Select/use sources of information on current events	Analyze current events	Analyze consumer issues	Analyze social issues	Analyze conservation/ecology issues	Analyze social impact of science/technology	Analyze economic impact of science/technology

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